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Installation and Operation of the Automated Route Reconnaissance Kit (ARRK)

Larry N. Lynch, Jill M. Jackson, Katie Fairley, Jeffrey L. Williamson, James C. Ray, Terry R. Stanton, T. C. Falls, Benjamin T. Webb, Jeffrey L. Crockett, and Jeff F. Powell

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ABSTRACT: The TeleEngineering Operations Center at the U.S. Army Engineer Research and Development Center has developed an initial capability to automate route reconnaissance. The Automated Route Reconnaissance Kit (ARRK) was developed to allow route information such as radius of curvature and slope to be determined as a vehicle is driving along the route. Other capabilities such as identifying obstacles and marking the location of bridges, ford sites, ferry sites, and tunnels are included in the ARRK. The ARRK software uses the collected data to produce a standardized route reconnaissance form that can be used for planning or executing missions.

The purpose of this report is to describe the components of the ARRK and to provide step-by-step procedures required to set up and operate the system and to process the collected data. Chapter 2 describes the components of the system. Chapter 3 provides details on installation of the equipment in a ground vehicle and the interconnections among the individual components. The setup and operation of the data collection and processing software is presented in Chapter 4. Chapters 5 and 6 explain how to collect and view the reconnaissance data. Adding the recon data to a route database is discussed in Chapters 7 and 8. Procedures to add additional data to the route database and create a final product are described in Chapters 9 and 10; methods of receiving technical support are provided in Chapter 11. Appendix A provides quick-start instructions for the system; Appendix B provides the bridge reconnaissance requirements.

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Preface

The work reported herein was funded under the TeleEngineering Operations Technology Demonstration Program at the U.S. Army Engineer Research and Development Center (ERDC), Vicksburg, MS. The report was prepared by Dr. Larry N. Lynch, Mses. Jill M. Jackson and Katie Fairley, Messrs. Jeffrey L. Williamson, James C. Ray, Terry R. Stanton, T. C. Falls, and Benjamin T. Webb, and MAJ Jeffrey L. Crockett of the Geotechnical and Structures Laboratory (GSL) and Mr. Jeff F. Powell of the ERDC Information Technology Laboratory (ITL).

The work at ERDC was performed under the general supervision of Dr. Albert J. Bush III, Chief, Engineering Systems and Materials Division, GSL; Dr. Robert L. Hall, Chief, Geosciences and Structures Division, GSL; Dr. David W. Pittman, Director, GSL; Dr. Charles R. Welch, Chief, Engineering and Informatic Systems Division, ITL; and Dr. Jeffery P. Holland, Director, ITL.

At the time of publication of this report, Dr. James R. Houston was Director of ERDC, and COL James R. Rowan, EN, was Commander and Executive Director.

1 Introduction

Operational deployments require units to conduct reconnaissance and analysis of routes and road networks at a faster rate than is possible with current staffing limitations. To overcome this deficiency, the ERDC developed an automated system for collecting, processing, and distributing route reconnaissance data. The Automated Route Reconnaissance Kit (ARRK) may be used on a wide spectrum of mounted reconnaissance missions or special data collection needs. It requires two persons: a vehicle driver and an operator. Still in the development phase, ARRK capabilities are evolving based on user feedback and ongoing field testing.

The ARRK, which consists of hardware and software, employs a ruggedized laptop computer to automatically and continuously collect route reconnaissance information without requiring the vehicle to stop or requiring personnel to leave the vehicle for routine calculations. Time, security, and accuracy concerns normally associated with a route reconnaissance are reduced. The ARRK collects photographs, voice recordings, global positioning system (GPS) locations, accelerometer data, and gyroscope data streams in three dimensions. Unlike traditional, manually recorded route reconnaissance efforts, the ARRK allows an operator with minimum training and experience to collect, process, and export the route information. The ARRK presents a chronological picture replay of the route and a georeferenced display of major features, bridges, fords, ferries, tunnels, obstructions, etc., that influence the classification and usage of the road or route. Personnel reviewing collected data can scroll through the stored data types to instantly locate specific features along the route; these data include automatically calculated slope, radius of curvature, and estimated ride quality. Reconnaissance data collected by the ARRK can be quickly converted to a preformatted report in accordance with the requirements of Field Manual (FM) 5-170 (Headquarters, U.S. Army 1998).

The TeleEngineering Toolkit (simply referred to herein as “the Toolkit”) software provides the mapping, georeferencing, displaying/viewing functions for the ARRK. For details on the Toolkit, refer to the “Installation and Use of the TeleEngineering Toolkit” manual (Williamson and Lynch 2003).

Chapter 2 provides a general description of the individual components of the ARRK. Chapters 3-9 provide instructions on installing the ARRK, conducting a recon, and processing the collected data. Chapter 10 provides guidance on creating useful presentations from collected and processed recon data; Chapter 11

provides contact information for obtaining technical support. To derive full benefit from the ARRK capabilities, follow the instructions presented in the same order in which they are organized by chapters. Appendix A provides "Quick Start" instructions, which basically summarize the steps presented in Chapters 3-9. A bridge reconnaissance guidance summary intended to supplement FM 5-170 is presented as Appendix B.

2 Components of the ARRK

The ARRK is packaged in one 13 in. tall × 22 in. wide × 18 in. deep Pelican® padded case for shipment; total weight of the loaded case is 70 lb. Figure 1 provides an illustration of a partially packaged ARRK.

Figure 1. ARRK partially packed in case

Each ARRK includes (Figure 2):

a. Global positioning system (GPS) (Quantity: 2) and supporting cable and external antenna.

b. Laptop computer, accessories, and PCMIA data collection card.

c. Laser range finder.

Figure 2. Various components[1]

d. Hand-held digital camera.

e. Route reconnaissance sensor box (gyroscope/accelerometer).

f. Power cables (civilian vehicle and NATO-slave-adapter cable).

g. Headset with microphone.

h. Windshield-mounted cameras (one with 45 deg angle bracket for a civilian vehicle and one with 90 deg angle bracket for a HMMWV or similar tactical vehicle).

i. Event marker and cable.

j. Supporting data and power cables.

[1] Figure 2 presented specific components that make up this demonstration version of the ARRK; however, this presentation does not represent an official endorsement.

3 Hardware Installation

The sections within this chapter describe steps and information necessary to setup the ARRK hardware in a vehicle. First, guidance on locating the ARRK sensor box will be provided. Second, guidance is given on connecting cables to the laptop; then, to the sensor box. Finally, remaining setup steps and final cable connections will be presented.

Locate the ARRK Sensor Box in a Vehicle

The ARRK sensor box (referred to hereafter simply as "sensor box") should be placed in the vehicle on a flat surface and secured to the vehicle so that it will not bounce when the vehicle is in motion. Figure 3 provides example installations in High-Mobility Multi-Purpose Wheeled Vehicles (HMMWVs). The slope and roughness measurements collected by the ARRK are based on acceleration; therefore, if the box is not secured to the vehicle, the data will be inaccurate. Also, it is important to maintain a constant speed during data collection (recon); rapid acceleration or braking could be recorded as an excessive slope.

Figure 3. Sensor box installed in HMMWVs

Connect Cables to the Laptop

There are three cables that must be connected to the laptop computer: (1) the umbilical cord, (2) a microphone connector that connects to the microphone jack

on the laptop, and (3) a serial port connector that connects to the COM port on the back of the computer.

The umbilical cord (Figure 4) is a thick cord consisting of a single connector on one end that connects to the sensor box and four connectors on the other end for connecting to the laptop. The four connectors on the umbilical cord that plug into the laptop are a laptop power cable connector, a universal serial bus (USB) connector, and two serial port connectors for the PCMIA card. The power cable recharges the laptop battery and operates the laptop when the battery power is low. The USB connector plugs into the back of the laptop and provides the video stream for the data collection. The two serial port connectors connect to the PCMIA card (Figure 5). One serial connector provides the GPS data stream; the other provides the accelerometer data stream. If the PCMIA card has been removed from the computer, it will be necessary to reinsert it into one of the PC slots located on the side of the laptop. Ensure that the PCMIA card is inserted properly into the laptop with the top of the card facing up (Figure 6). Inserting the PCMIA card into the laptop incorrectly can cause damage to the card. Ensure that all of the connections are secure. If the connections are not secure, the data will not be collected correctly (Figure 7).

Figure 4. Umbilical cord

A headset (Figure 8) is provided with the ARRK. For recording recon data, the microphone is the only headset component that is required to be connected; it should be plugged into the back of the laptop (Figure 9). The microphone is used to record any voice narration that may be deemed useful during the reconnaissance. Figure 10 demonstrates the cable being connected to the PC.

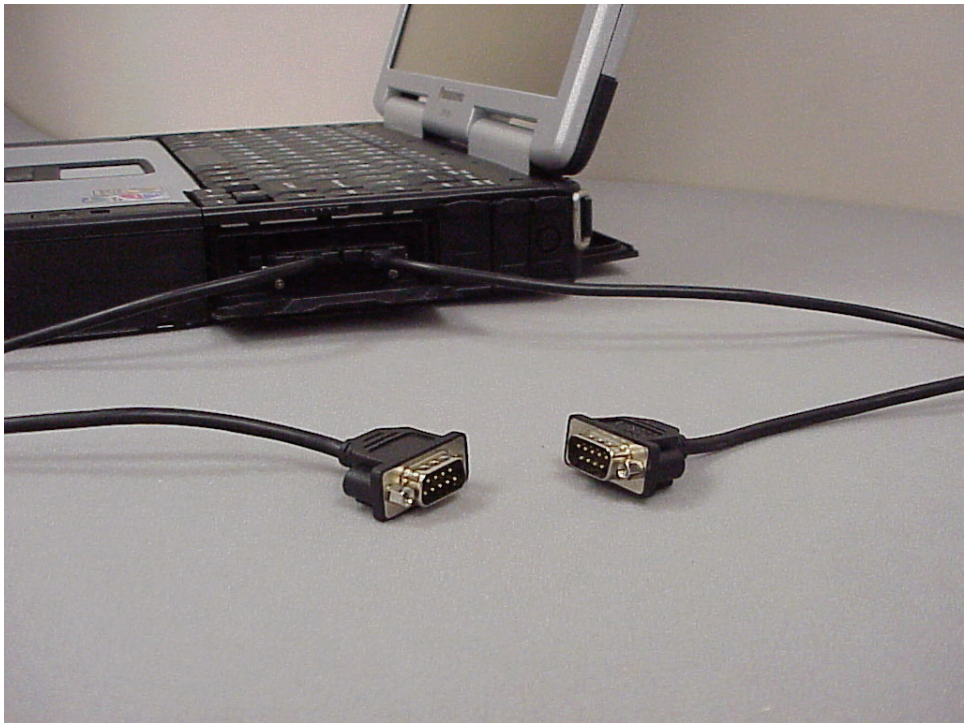


Figure 5. Serial connectors

Figure 6. PCMIA card

Figure 7. PCMIA card partially inserted

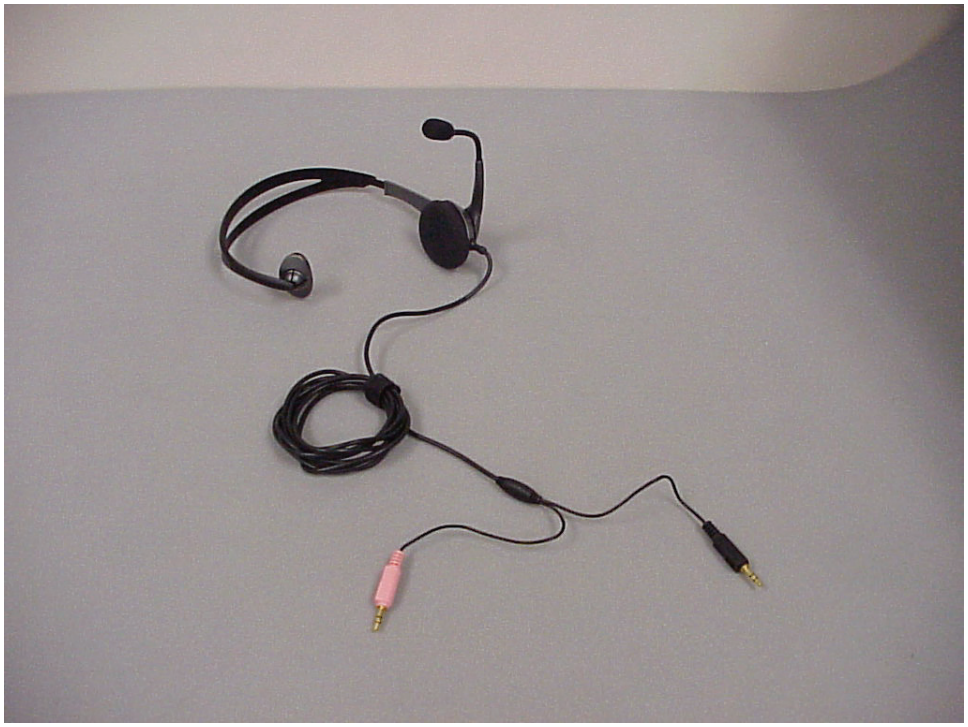


Figure 8. Headset with microphone

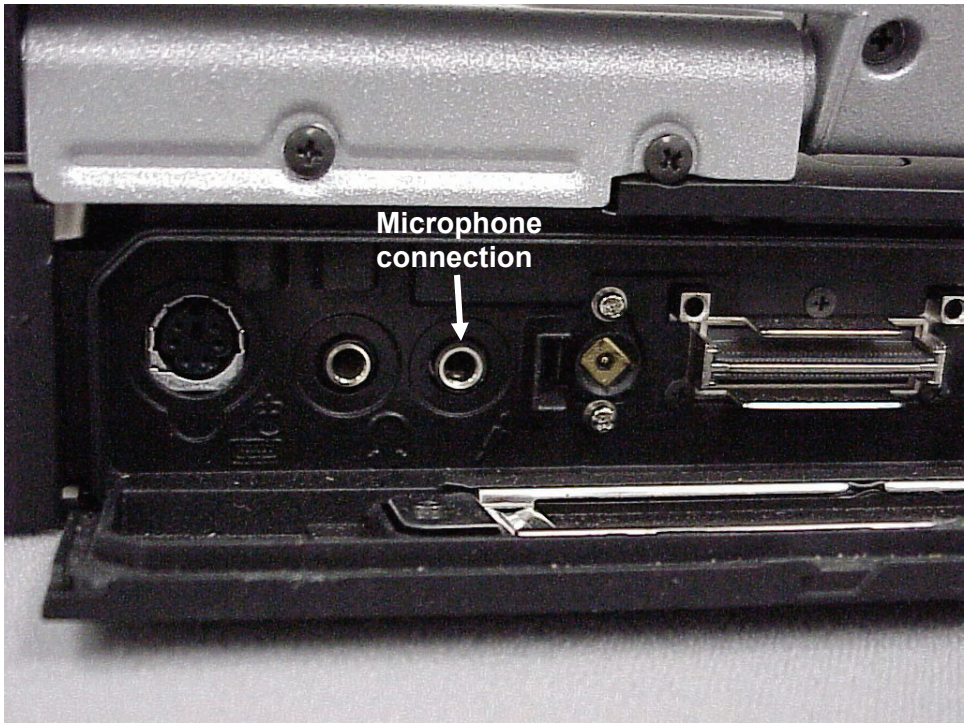


Figure 9. Microphone port on PC

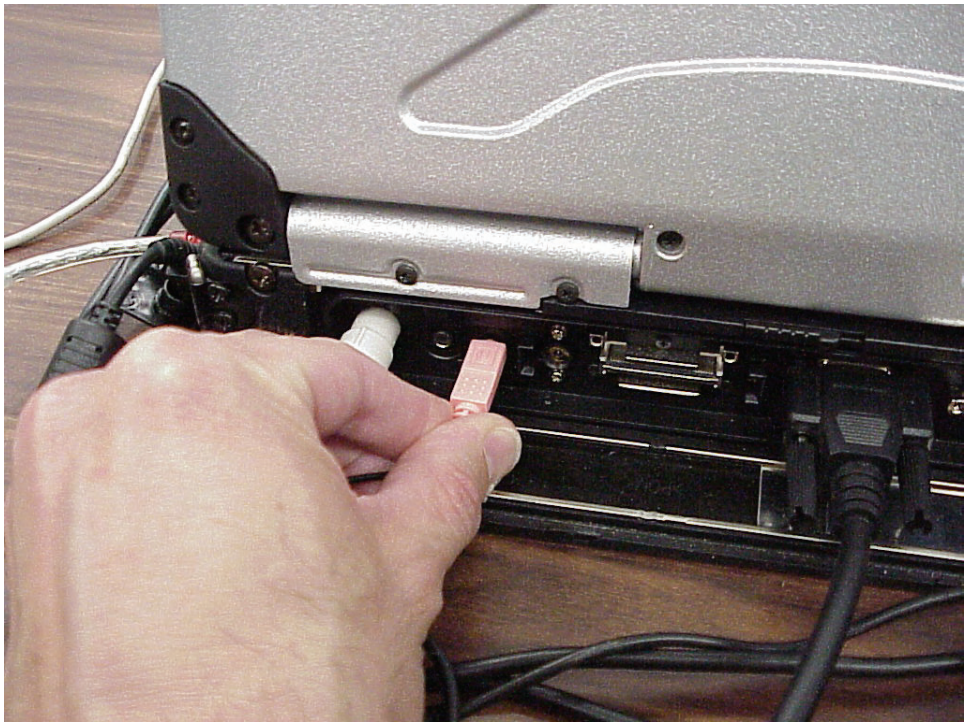


Figure 10. Microphone connected to laptop

The last cable to be connected to the laptop is the event marker, also called the “voice record toggle” (Figure 11); it is connected to the serial port (COM port 1) on the back of the laptop. The event marker enables the user to activate the voice recording function of the data collection. While the button is depressed, the system records audio collected by the microphone on the headset. Figure 12 demonstrates connecting the cable to the laptop.

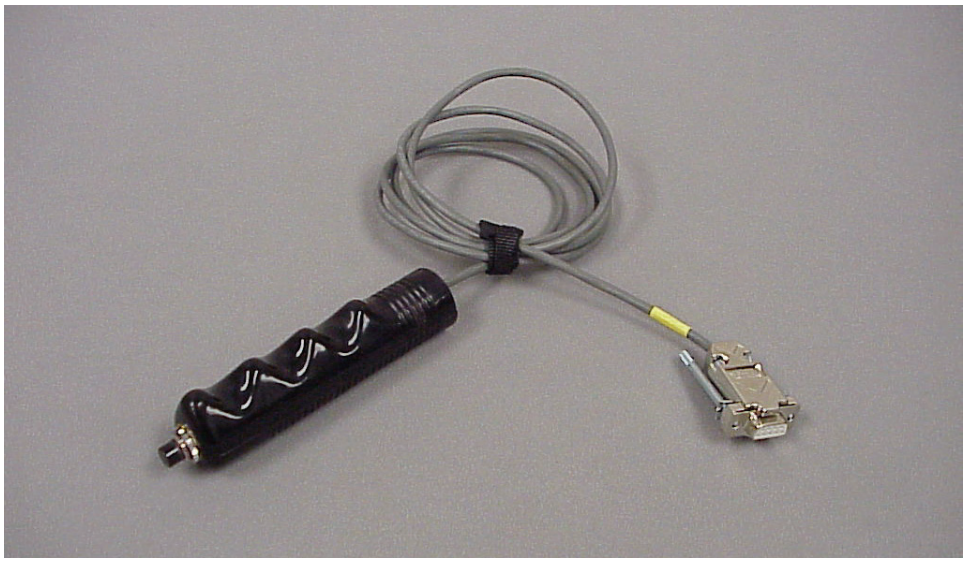


Figure 11. Event marker

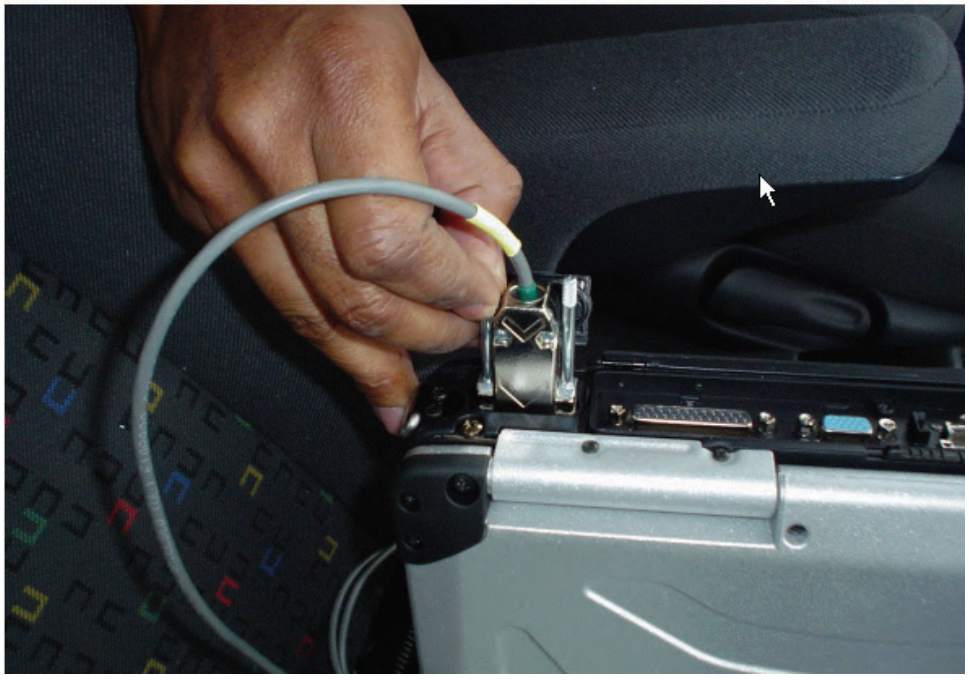


Figure 12. Connecting the event marker to the laptop

Connect Appropriate Cables to the Sensor Box

Next, connect the cables to the sensor box (Figure 13). The four cables/cords that must be connected to the sensor box are (1) umbilical cord, (2) power cable, (3) GPS cable, and (4) windshield camera cable. The umbilical cord (Figure 4) connects the sensor box to the laptop. Connect the military connector end of the umbilical cord to the large connector on the sensor box labeled “Laptop”; this cable provides power to the laptop and transfers data from the collection devices to the laptop for recording. Next, connect a power cable. One power cable has a cigarette AC adaptor (for civilian vehicles); the other has a NATO-slave-cable adapter (for military vehicles) (Figure 14). The power cable provides necessary power for the sensor box and powers the laptop and GPS so that they are not dependent on battery power.

Connect the large military-style connector on the GPS cable to the sensor box and the smaller connector to the GPS (Figure 15); do not power-up the GPS until after the computer is completely booted. If the GPS is turned-on first, the laptop will function erratically. An example of erratic operation is the mouse cursor moving erratically over the laptop screen; the GPS was probably turned-on before the laptop. To correct this problem, turn-off the GPS and laptop; then, completely boot the laptop before turning on the GPS.

An external antenna (Figure 16) is provided for the GPS to collect accurate location data. Connect the external antenna to the back of the GPS (Figure 17); then, mount the magnetic antenna base to the roof of the vehicle or any other flat metallic surface not directly affected by harsh factors such as engine heat (Figure 18).

Two windshield cameras are provided with the system (Figure 19). One camera provides a 45-deg mounting plate for use in commercial vehicles; the other provides a 90-deg mounting plate for use in a tactical vehicle, such as a HMMWV. Figure 20 demonstrates affixing the 45-deg camera to the windshield of a commercial vehicle. Connect the camera cable to the sensor box (Figure 21) and affix the appropriate camera to the windshield. Only one windshield camera can be used at a time.

After the cables have been connected to the sensor box, place the sensor box in the vehicle with the cable connections facing the rear of the vehicle. Figure 22 provides an illustration of the “Forward” mounting indicator on the sensor box, which will assist in properly placing the box. Normally, the sensor box is mounted on the rear floorboard of commercial vehicles (Figure 23). Small, self-tapping screws are provided to secure the box to the floorboard. Alternatively, a sand bag or other heavy object placed on the sensor box will help secure it. The system must remain in place during data collection.

In tactical vehicles, the location of the sensor box may depend on other equipment in the vehicle. Whatever location is selected, the system must be secured to the vehicle using mounting screws or a sandbag.

Figure 13. ARRK sensor box

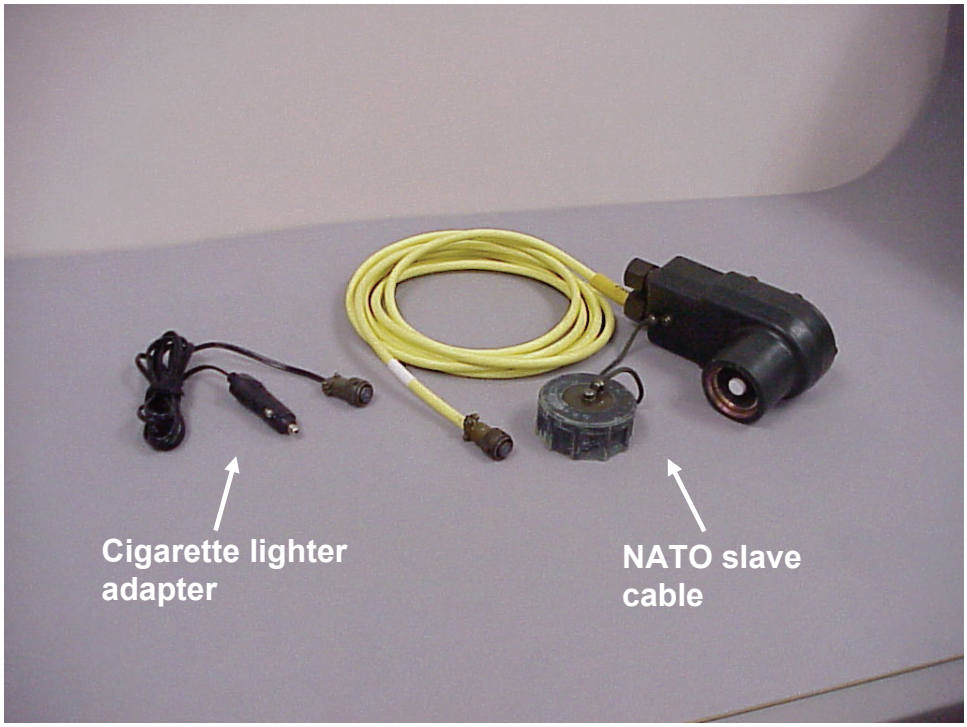


Figure 14. Cigarette lighter adapter and NATO slave cable

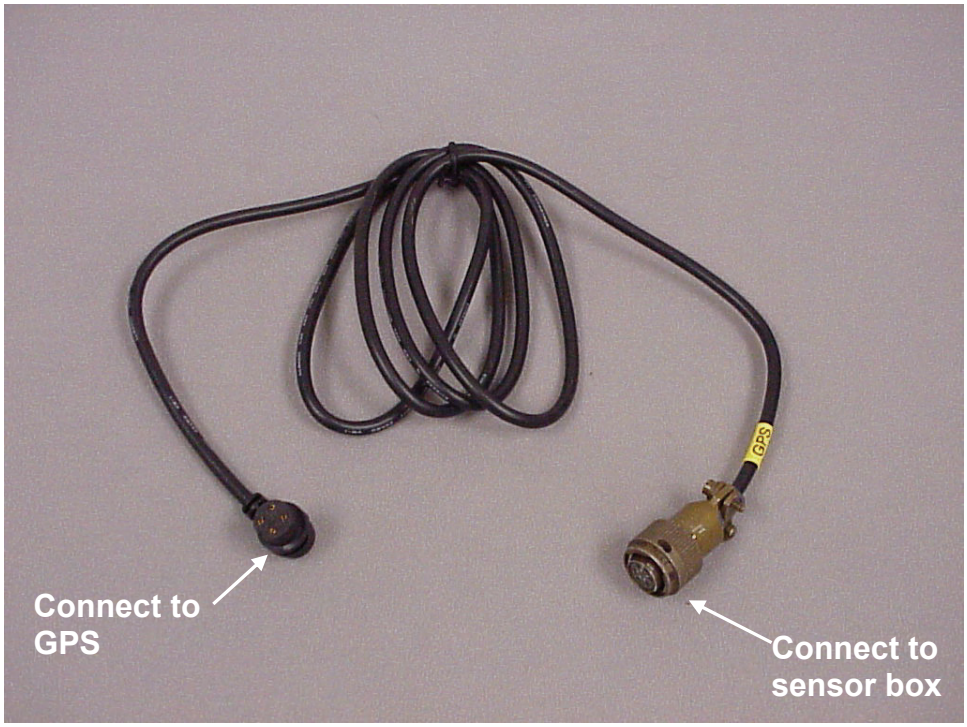


Figure 15. GPS cable

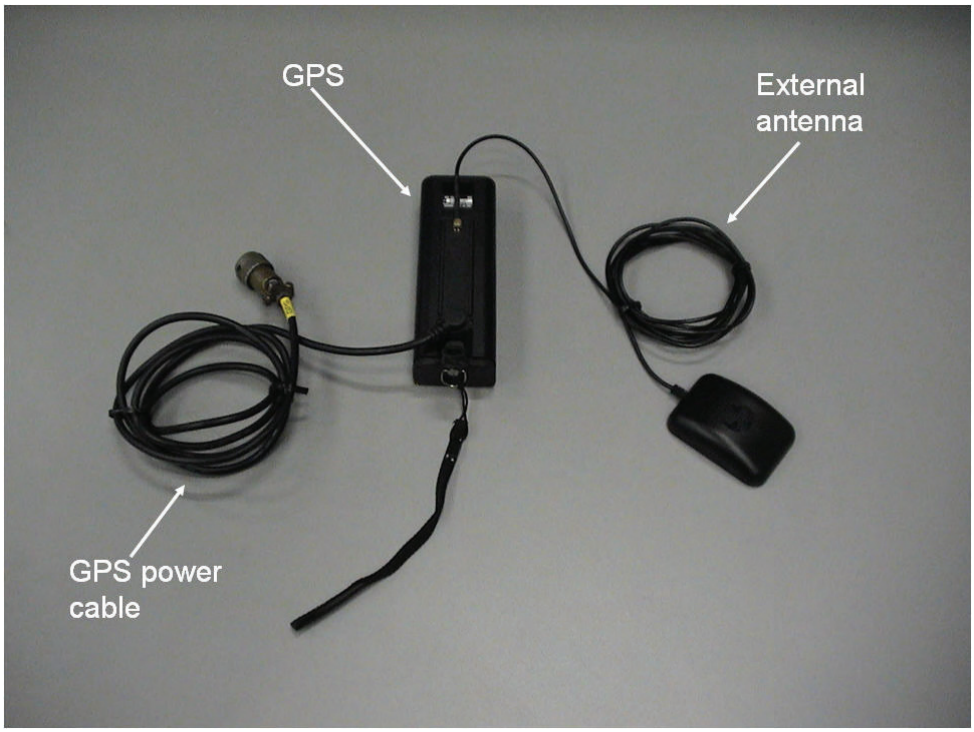


Figure 16. External antenna cable

Figure 17. GPS connections

Figure 18. Antenna mounted on top of vehicle

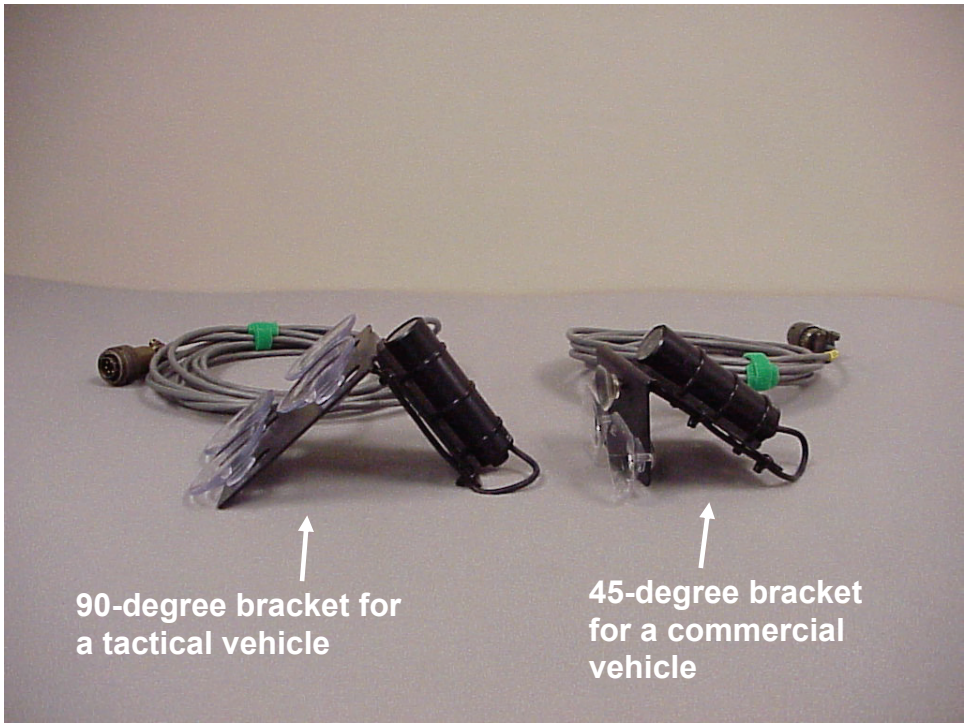


Figure 19. Two windshield cameras

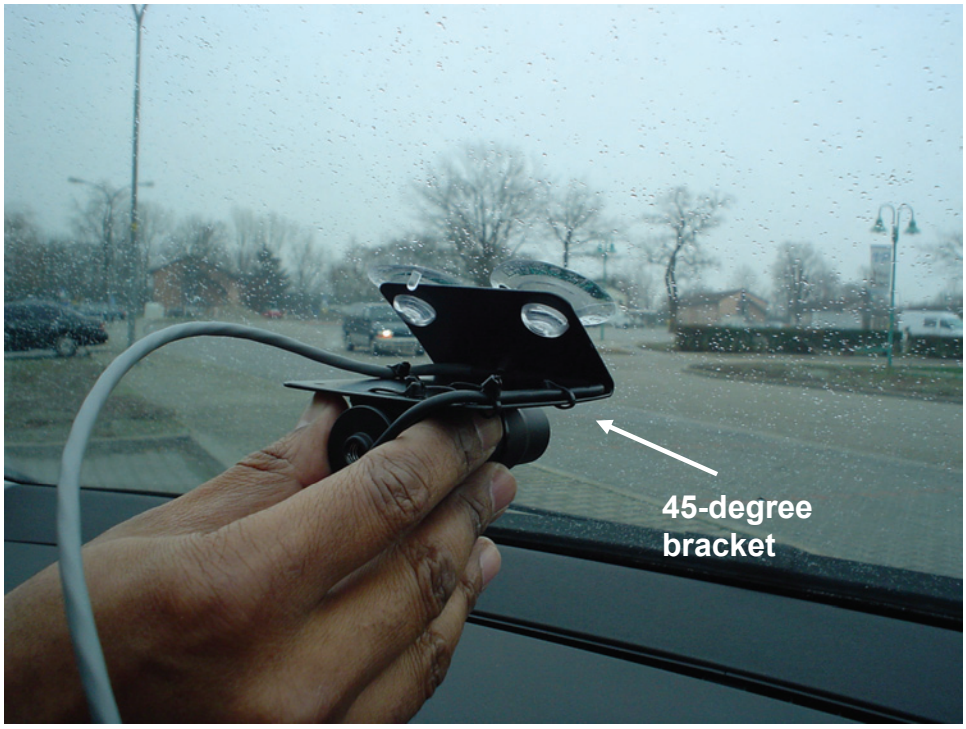


Figure 20. Affixing camera to commercial vehicle windshield

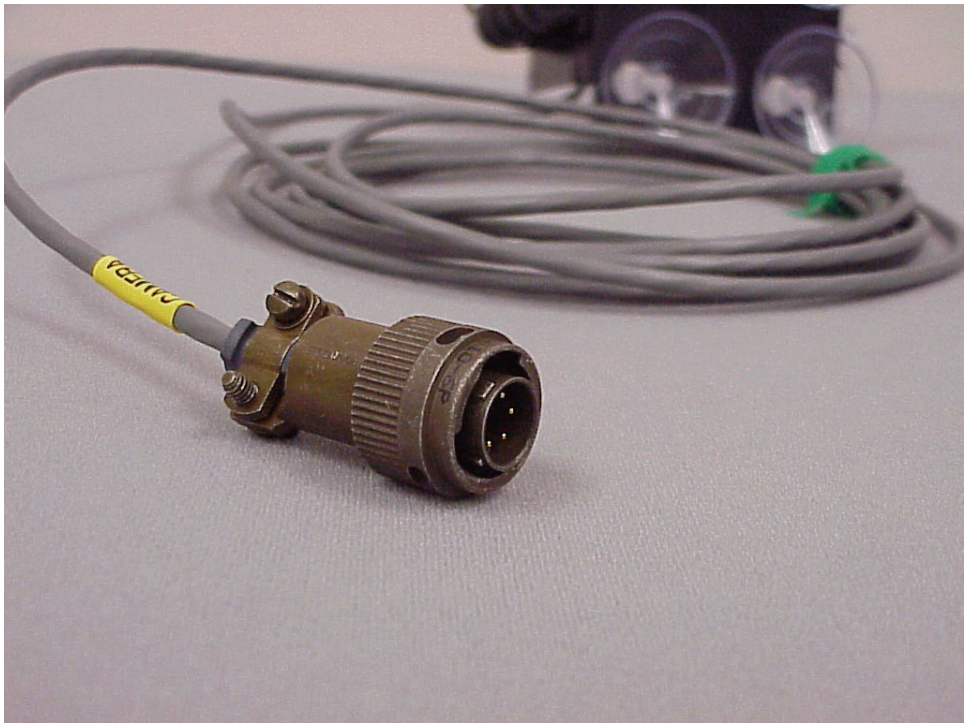


Figure 21. Camera cable connection to the ARRK sensor box

Figure 22. Directional indicator on ARRK sensor box

Figure 23. ARRK sensor box placed on floor of commercial vehicle

Once the sensor box has been mounted and all cables are connected, the system can be powered-up. The first step is to turn-on the laptop; enter the user identification and password. Turn-on the GPS and allow it to completely power-up. (Note: The specific instructions in this manual are related to the Garmin 12 XL GPS as shown in Figure 24. Refer to the manufacturer's literature if a different GPS is used.) Most GPS systems will automatically acquire satellites and determine their geographic location. If a "Select Init Method" error statement is displayed, press the "Page" button several times until the "ACQUIRING EPE" page is displayed; a list of countries and states will be displayed. Selecting your current location will assist the GPS in acquiring its location.

If this is the first time your GPS has been used with the ARRK, verify the interface settings before proceeding. To view the settings, press the "PAGE" button several times until the MAIN MENU screen is displayed. Select "SETUP MENU" from the MAIN MENU and then select "INTERFACE." The settings on this display should be "NMEA/NMEA" and "baud rate = 4800." If these are not the settings shown on your GPS, scroll through the settings and select them from the menu.

The ARRK equipment is now ready to collect reconnaissance data. Figure 25 provides an illustration of the ARRK installed in a commercial vehicle, with the operator ready to begin a recon. To proceed, you will need to set up the Toolkit software to record data as described in Chapter 4.

Figure 24. Garmin GPS

Figure 25. ARRK and operator in a civilian vehicle

4 Toolkit Software Setup

For collecting, georeferencing, storing, and displaying recon data, the ARRK uses the TeleEngineering Toolkit. This chapter will provide details necessary to prepare the toolkit for data collection. For more details on using the Toolkit, refer to the Toolkit user's manual listed in the reference section of this manual.

Ensure the screensaver option on the laptop is "off" prior to collecting reconnaissance data; the Toolkit may shutdown and stop collecting data if the screensaver activates during a recon.

Start the Toolkit by double-clicking the Toolkit icon (the red Engineer Castle) on the desktop using the left mouse button. Open an existing project by selecting "File," then "Open Project" from the top left hand corner of the display. The project can be selected by clicking on the corresponding red rectangle from the Open Project map, or by browsing existing projects and their folders. To browse existing projects, press the  button on the Open Project window. Select the ".tep" file to open an existing project.

Once the project is opened, the name of the project will be displayed in the upper portion of the "View Control" window. The display to the right of the "View Control" window will be blank (black) or, the last map background displayed for that project will be displayed. If it is blank, a map background can be displayed by first clicking on the "Background" tab (Figure 26). The display in the "View Control" window will change to allow the user to select the desire map background. Then, use the pull-down menu next to "Types" and select the desired type of map background. When conducting a reconnaissance, it is recommended to use a high-resolution product; therefore, the types selected will normally be "CADRG/CIB" or "IKONUS." Next, move the mouse cursor to the "Source" pull-down menu and select the desired scale. When "CADRG/CIB" is selected as the type, the source will generally be 1:250K Joint Operations Graphic (JOG) or Control Image Base (CIB), 10 m or 5 m. Next, press "Redraw"; the map background will be displayed. If the map background does not display in the window, no data exist for the extents of the display window.

To determine if map data have been loaded for your area of interest, select the "Extents" tab (Figure 27). Move the mouse cursor to the pull down menu under the green box and select the map background product of interest (Figure 28). A series of red boxes will be displayed showing available data for

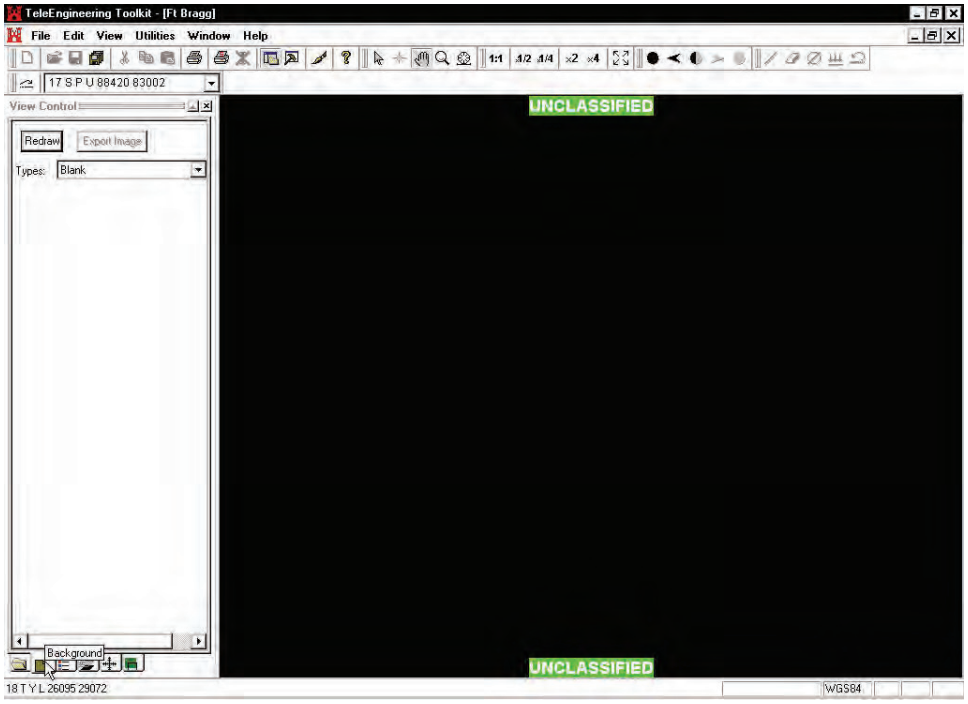


Figure 26. Background tab

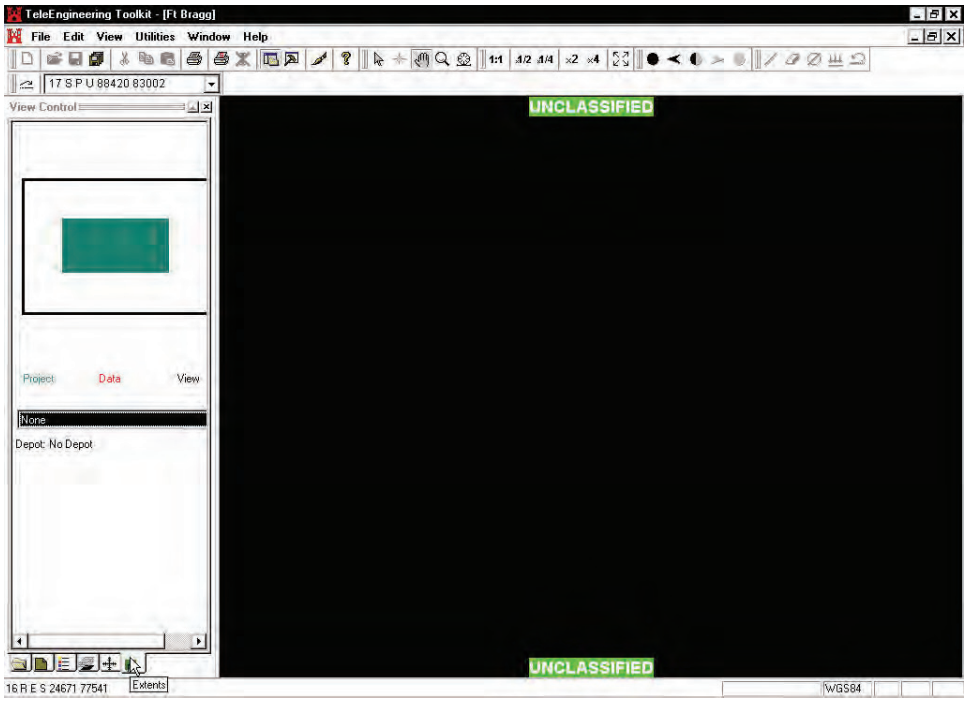


Figure 27. Extents tab

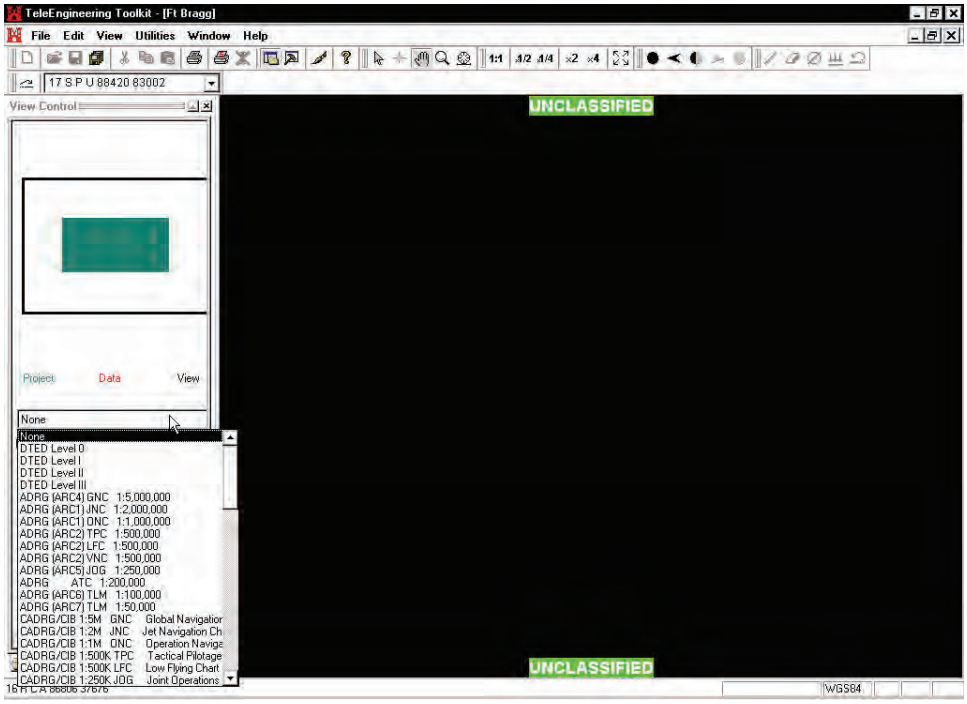


Figure 28. Selecting product of interest

your area of interest. The black outlined box represents the current extents of the current view on the display.

Select the "Project" tab in the lower left portion of the screen to return to the project information and project components.

Expand the project by clicking on the "+" symbol to the left of the project name in the "View Control" window. A list of items will be displayed under the project name. Click the right mouse button on the "Recon" folder; select "New Database" from the pop-up menu. A "New Database" window (Figure 29) will be displayed; enter a name for the reconnaissance data and select a location (folder) to save the reconnaissance data. Data can be saved to any location on the hard drive; typically, data are saved in a folder titled "C:\TETK\Recon*project name*." Saving the data in this location simplifies transferring data to other computers/ systems. After selecting the path, click "OK."

Expand the "Recon" folder[1]; the name of the recon data should be displayed. Right click on the "named" recon folder and select "Record Recon" from the list (Figure 30); a "Record Data" window will be displayed (Figure 31).

[1] Warning: Do not run the RECON portion of the Toolkit after the laptop has suspended or "gone to sleep." Doing so will cause problems with recording the audio track; the system will falsely appear to record audio. If necessary, reboot the laptop. Check prior to an extended recon; collect a short segment (100 yd) of data and verify the audio recording by playing the short segment to ensure proper execution.

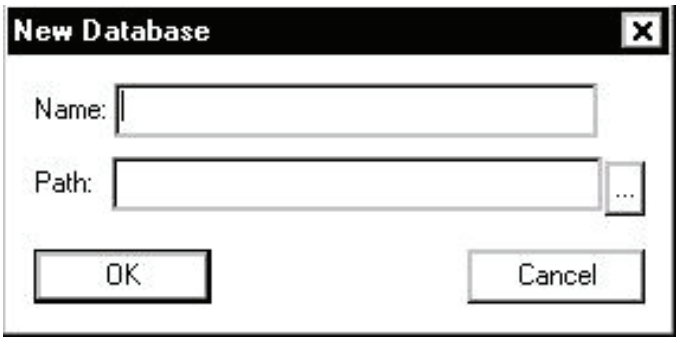


Figure 29. New Database window

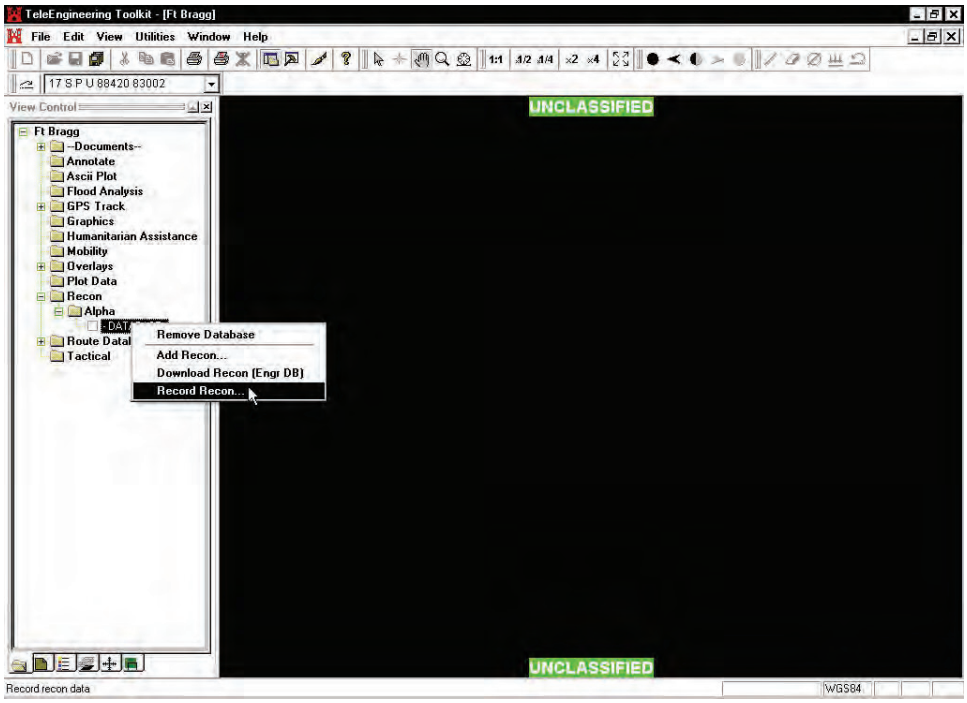


Figure 30. Database view

To collect reconnaissance data, name the recon, and press “OK”; the “Record” window will be displayed.

Press the “Output Control” button near the top of the Toolkit window to display the output control portion of the window; selecting “View” and “Output Control” also accomplishes this task. The “Output Control” portion of the window displays data collected by the ARRK. The output from the camera should be displayed on the left portion of the “Output Control” window; a line graph should be displayed on the right portion (Figure 32). The camera output window can be relocated, as shown in Figure 32. To adjust the size of the window, move the cursor to the border between the “Output Control” window

Figure 31. Record Data window

and the map display window; then, depress the left mouse button and drag the cursor to indicate the desired size of the window.

Move the cursor to the line graph area and click the right mouse button; the "Graph Control" window will be displayed. In the pull-down boxes, the words "Records," "Sound," and "Z-Acc" should be displayed. If they are not, move the cursor to the pull-down boxes and select them from the list. Other items to display on the screen may also be selected from the list.

To change the color of the lines representing the accelerometer data displayed in the line graph, move the cursor to the small box next to the item and press the left mouse button; color options will be displayed. Select the desired color and press "OK." To change the graph scale on the chart, select the "Scale" tab; select the desired scale from the pull down menu. The "Graph Control"

Figure 32. Output control

window can be closed by clicking on the “X” in the upper right corner of the “Graph Control” window.

If the system is configured properly, the view from the camera should be visible in the Recon Picture window; a small camera and GPS icon should be visible in the lower right portion of the screen within the graph. The camera and GPS icons at the bottom of the data collection chart should be scrolling from right to left indicating data are being collected. The Z-acceleration data (surface roughness) should also be visible, but due to the slight variation in the graph, the data may be difficult to distinguish.

A yellow and red circle with an arrow should also be displayed in the map window. The circle indicates your current geographic location on the map; the direction the system is facing is indicated by the arrow.

To check the audio connection, press the toggle button on the event marker and speak into the microphone. Audio data should be visible in the line chart (represented graphically) in the lower right portion of the screen.

If all data are visible, the system is operational; you are ready to conduct a recon. If data are not visible, press the “SETUP” button in the recorder box to inspect the system settings. The default readings in the “Recorder Setup” (Figure 33) window should be:

a. Camera – Belkin USB (352X288).

b. Seconds/Frame – 2.5.

c. Compression Quality – 70.

d. GPS Port – COM 4.

e. GYRO Port – COM 3

f. On – checked.

g. Accel Pkg – 10 g.

h. Sound Button Port – COM 1.

i. IRI-ACC On – Unchecked (this is not available on all systems).

If these settings were already correct in the “Recorder Setup” window and the system is not working, change the GPS Port to COM 5 and the GYRO Port to COM 6. On some laptops, the COM ports may be 6 and 7, or some other numbers that are listed on the keyboard of the Toughbook laptop. Continue to select different COM port combinations until the data are displayed. You may need to press “OK” between each selection to register the change with the software before data become visible on the “Output Control” window. After completing the setup, press “OK”; the system is now ready to record recon data.

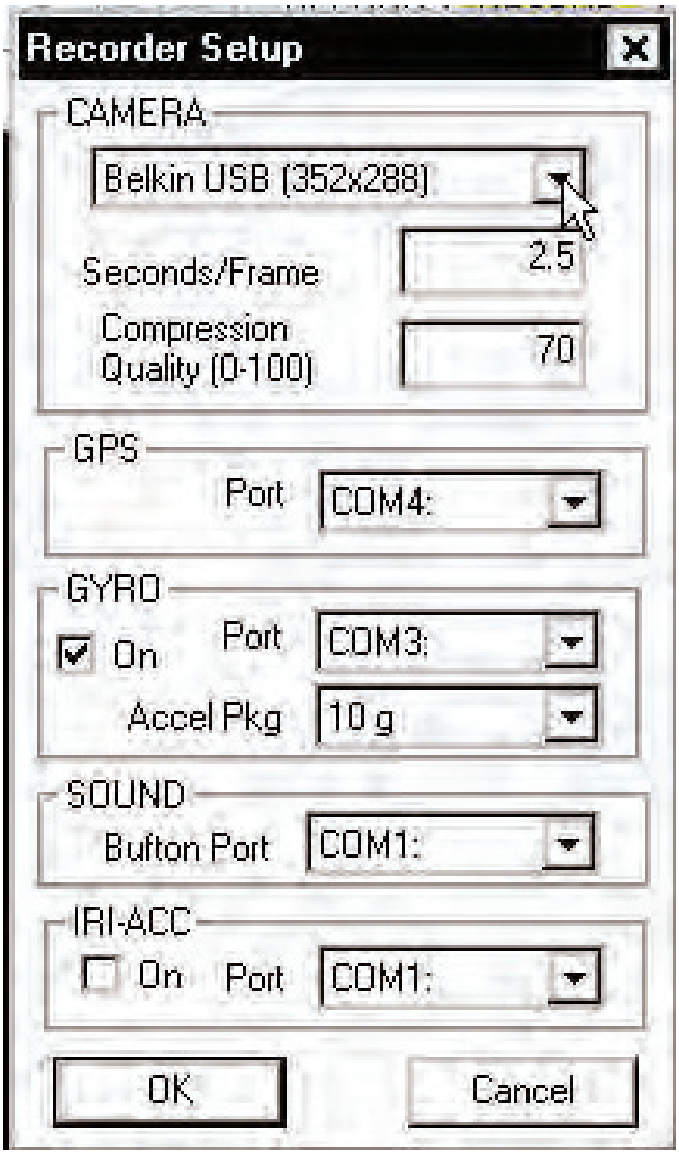


Figure 33. Setup

5 Conducting a Recon

This chapter describes the steps required to conduct a recon using the ARRK. Exact procedures followed when conducting a reconnaissance will depend on the mission; refer to FM 5-170 for the tactics, techniques, and procedures of conducting a reconnaissance mission. Guidance and steps of operation included herein are based on feedback provided by users during initial development of the ARRK; modify as needed.

Before beginning actual data collection, measure pavement lane width and total width of the roadway. Perform these measurements each time there is a noticeable change in pavement width; if these assessments are recorded at the start of the recon, it will be possible to estimate changes in pavement width when "playing-back" the collected video at a later time.

After lane width has been measured, press "Record" in the upper left of the "Recorder Window" (Figure 34) and begin driving the designated route.[1] The status indicator provides the status of the data collection. Prior to pressing "RECORD," the status is shown as a yellow box displaying "RECORD OFF." Once the "RECORD" button has been pressed, the button changes to "PAUSE" (ready to "pause" the data collection when pressed); the status is shown as a red box displaying "RECORD ON." Figure 35 demonstrates these options.

Audio (voice) can be recorded during the recon to identify points of interest or concern and to add measurement data (i.e., pavement lane width, height of overhead obstructions, widths and heights of tunnels, etc.). To record audio information, depress the event marker button and speak directly into the microphone; release the button when completed recording audio. At the start of a recon, verbally record the start time, date, weather conditions, name of the road, lane width, total width, pavement type, etc.

Continue driving the route and verbally identifying items of interest while depressing the event marker toggle and speaking into the microphone; also mark the events by pressing the appropriate button in the "Record Window" (Figure 36). Recommendations for recording data related to specific items of interest include:

[1] It is recommended that a "recon team" consist of at least two persons: a driver and an ARRK operator.

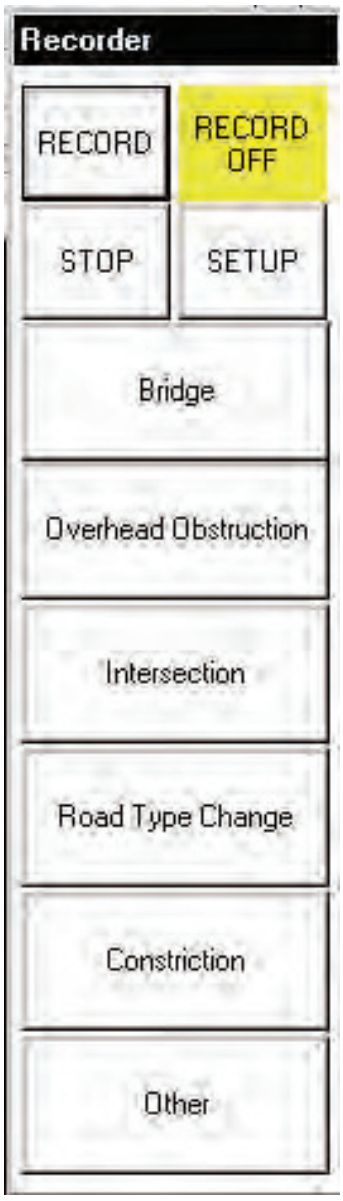


Figure 34. Record button

a. *Bridge*. Depress the event marker button and verbally indicate that a bridge is being approached; you may want to verbally indicate the beginning and the ending of the bridge. At the mid-point of the bridge, press the “Bridge” button on the “Recorder Window. A bridge icon will be placed at the location. If a dismounted recon will be conducted at the bridge, travel in the vehicle across the bridge, mark the location as described, press “PAUSE”; then, stop the vehicle, dismount, and collect data. Once bridge data have been collected, press “PAUSE” to restart recording data and continue the route recon. Make an audio recording of bridge data collected while dismounted.

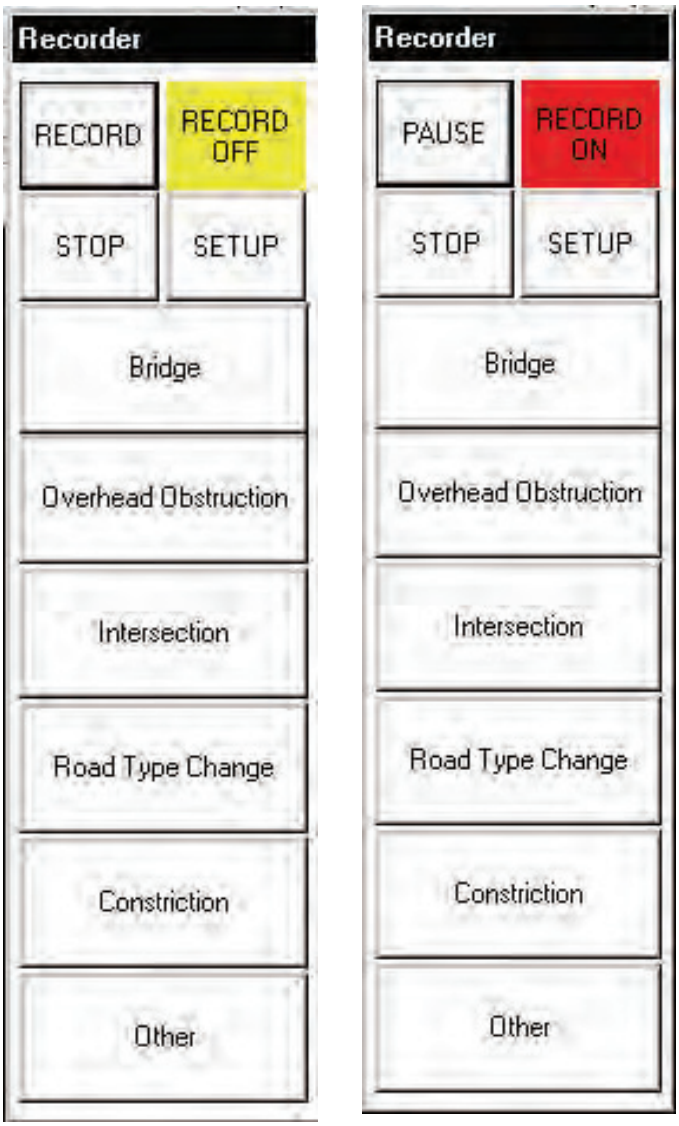


Figure 35. Status indicator

b. *Overhead obstruction*. An overhead obstruction may be a tunnel, underpass, overhead wires, overhanging building, or a similar item that has a clearance of less than 4.3 m. To record an overhead obstruction, record a verbal description of the overhead obstruction. If it is possible to drive the recon vehicle under the obstruction, press "Overhead Obstruction" on the "Recorder" window; this will place an obstruction icon at the midpoint of the obstruction. If the vehicle cannot be driven under the overhead obstacle, drive as close to the obstacle as possible and press "Overhead Obstruction."

c. *Intersection.* The location of intersections or entrance and exit ramps on highways and interstates are often noted to assist in the planning of main supply routes, or to help in selection of base camp sites. To record an

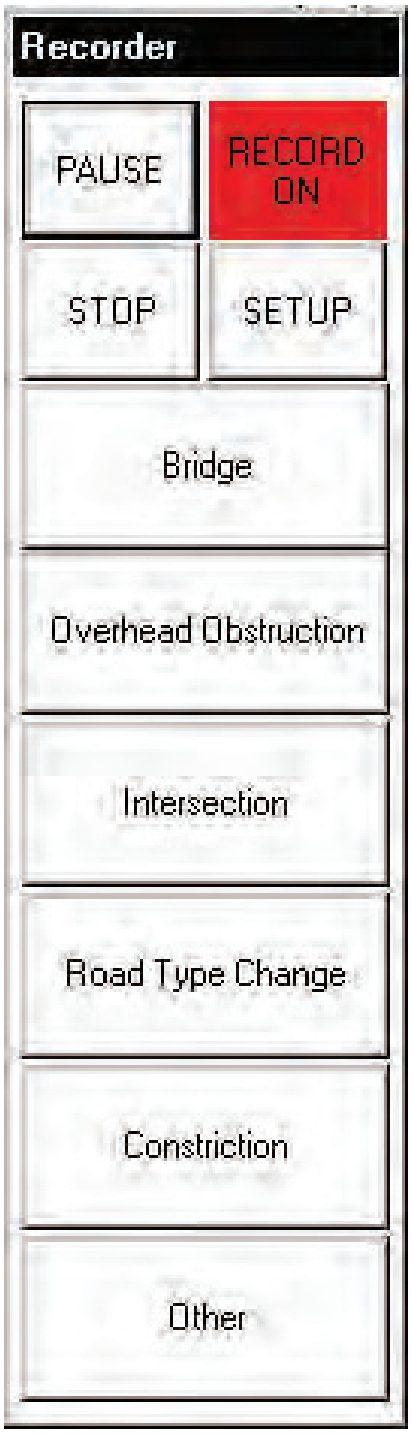


Figure 36. Event marker buttons

intersection, verbally record that an intersection is being approached. If possible, provide the name of the intersecting road. Press “Intersection” at the mid-point of the intersection to place an intersection icon on the screen (map) at that geographic location.

d. *Road type change*. A road type change indicates the geographical location the wearing surface of the road changes, the number of lanes change, etc. To mark road changes, press "Road Type Change" and verbally describe the change while recording audio. A road type change icon will appear on the map at that location.

e. *Constriction*. Constrictions are reductions in the travel width of the roadway and are identified based on the type of traffic. Table 1 provides criteria for defining constrictions. To record a constriction, press "Constriction" and verbally describe the constriction while recording audio. See FM 5-170 for more information and guidance.

Table 1
Criteria for Defining Constrictions

	Limited Access	Single Lane	Single Flow	Double Flow
Wheeled	At least 3.5 m	3.5 to 5.5 m	5.5 to 7.3 m	Over 7.3 m
Tracked and combination vehicles	At least 4.0 m	4.0 to 6.0 m	6.0 to 8.0 m	Over 8 m

f. *Other*. This category includes other items important for the specific recon; it could include gas stations, staging areas, etc. and is denoted by verbally recording information about the item. Press "Other" in the "Recorder Window" to mark the geographic location of the item.

g. *Sharp curves and steep slopes*. Sharp curves and steep slopes are calculated by the Toolkit after the recon is completed using collected data; there is no need to measure curves and slopes. When a sharp curve or steep slope is approached, record a verbal indication. Remember, curves and slopes are calculated using data collected by the ARRK's accelerometer and GPS. If the vehicle rapidly accelerates or decelerates, the ARRK may record that event as a steep slope. Rapid lane changes could be confused as a sharp curve. Recording verbal indications of suspected sharp curves and steep slopes will assist in processing and correcting data after the recon.

When completed with the recon, press "STOP" in the "Recorder Window"; data collection will end and a file name will appear in the "View Control Window." The file name will contain the name entered at the beginning of the recon, plus a time-date stamp indicating the start of the recon.

To view the completed recon, double click in the box to the left of the desired file (Figure 37).

Stop recon data collection at least every four hours and start a new recon to prevent the resulting file size from becoming excessively large.

Figure 37. Viewing the completed recon

6 Viewing the Resulting Recon

Chapter 6 presents steps necessary to view the collected recon data and to calculate slopes, curves, and the International Roughness Index (IRI).

Instructions presented within this chapter assume that you are processing the collected data on the collection computer. Detailed instructions for copying recon data to other computers for centralized processing and sharing of data are discussed in Chapter 10.

1. Open the Toolkit project containing the recon data.

2. Expand project components by clicking on the "+" sign to the left of the project name in the "View Control Window" (Figure 38).

3. Display a map background in the display window by clicking on the "Background" tab on the lower left side of the screen.

4. Move the cursor to the pull-down menu labeled "Types" and select the desired map background type.

5. From the "Source" menu, select the desired scale. For most recon missions, use CIB 1 or CIB 5 (or similar). See Figure 39.

6. Press "Redraw"; if data for the area of interest are loaded, the selection will be displayed in the map window.

7. Press the "Project" tab in the lower left portion of the screen to view the project components.

8. Expand the "Recon" folder by selecting the "+" sign on the left of the "Recon" folder (Figure 40). The subfolder used to collect the recon data should now be displayed.

9. Expand the desired recon subfolder by selecting the "+" sign next to it. The word "DATABASE" and the collected recon files should be visible. For example, a recon named "AO Tiger 02" would now appear as "AO Tiger 02 – 1635Z26APR04," where "1635Z26APR04" is the date-time

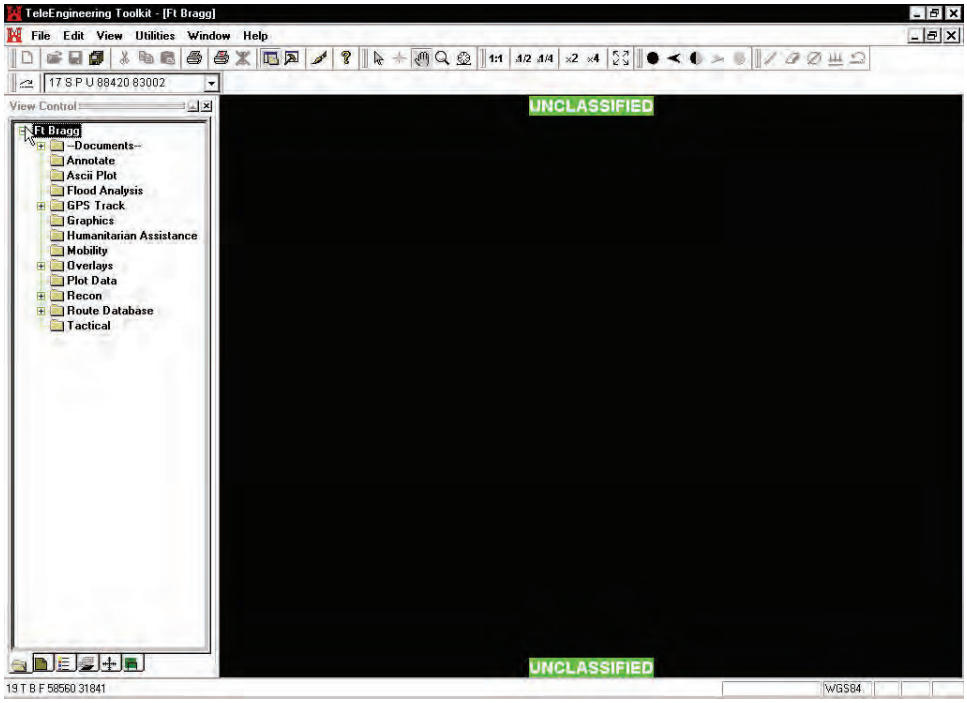


Figure 38. Toolkit window with project components expanded

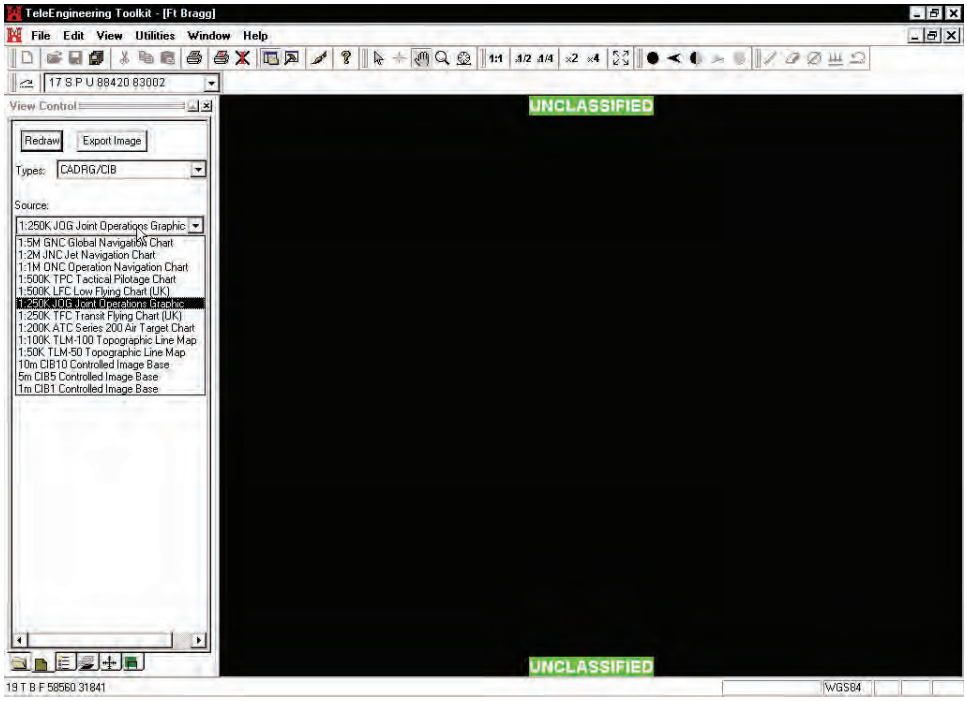


Figure 39. Displaying a map

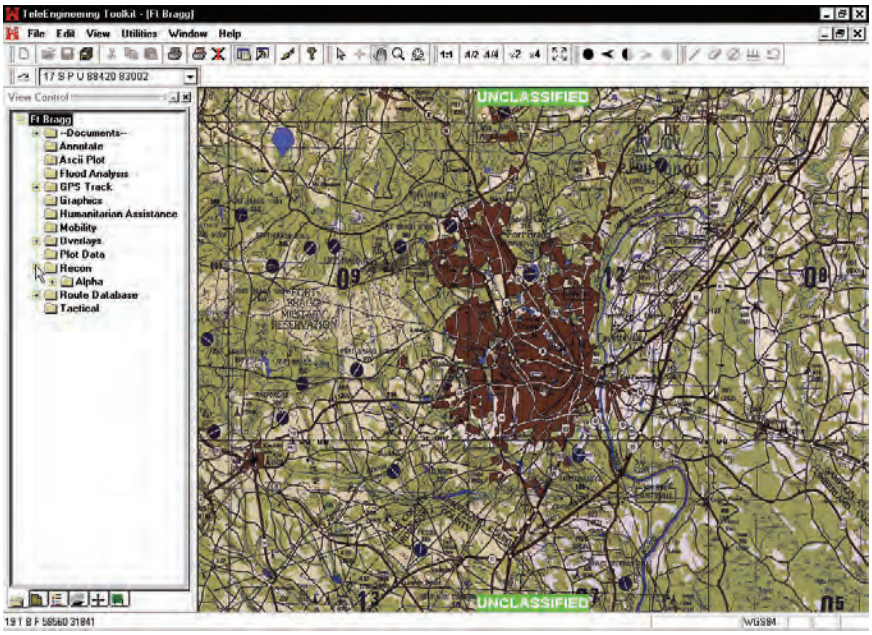


Figure 40. Expanding recon folder

group. Double click in the box to the left of the desired recon file. A check mark will appear in the box; recon data should appear in the window (Figure 41).

Figure 41. Displaying recon

10. If data do not appear in the screen, click on the "Show Recon View Form" button on the right side of the screen; this will produce the "Recon:Picture" Window and the "Recon:Control" window, as shown in Figure 41.

11. Click "Play" in the "Recon:Control" window. Once "Play" is pressed, the recon video will start playing; recon data will be automatically centered in the main display or map window. Press "Pause" or "Stop" to stop playing video.

12. To zoom-in, press the "Magnifying Glass" button along the top of the screen; move the mouse cursor to one corner of the desired view and depress the left mouse button. Continue to depress the left mouse button while "dragging" a "zoom-box." When the box covers the desired zoom area, release. The display will zoom-in to the area selected.

13. Press the "Edit Recon Properties" button on the toolbar on the right side of the screen. The "Recon Info" window will be displayed (Figure 42).

14. Press the **"Compute Curves"** button, then the **"Compute Slopes"** button, and lastly, the **"Compute IRI"** button. (**NOTE**: The IRI calculation is not operational on all versions of the Toolkit and ARRK: a hardware modification is required for activation of this feature. If the IRI function is not active, an error message stating "No accelerometer data" will be displayed. Simply click "OK" and continue). If sharp curves or steep slopes were recorded by the ARRK during recon, they will be displayed along the recon trace in the main display window. Press "OK." **This step should only be conducted once for each of the recon data files.** Conducting this step more than once will create duplicate data in the "Route Database."

15. Right click on the activated (highlighted) recon file under the Recon Folder on the left side of the screen (i.e., the one that was just used to calculate curves and slopes) and select **"Save Objects (Engr Db)"** from the list. This will add collected recon data to the Engineering Route Database, including bridges, fords, ferries, and tunnels marked by using the buttons from the "Recorder" window. **This step also should only be conducted once for each of the recon data files.** Conducting this step more than once will create duplicate data in the "Route Database."

16. Ensure that the "Location" icon (the yellow and red circle with an outward pointing arrow) is located at the beginning of the route recon data by selecting "Segment" from the pull down menu in the "Seek" portion of the "Recon Control" window; then, press the "Previous" button .

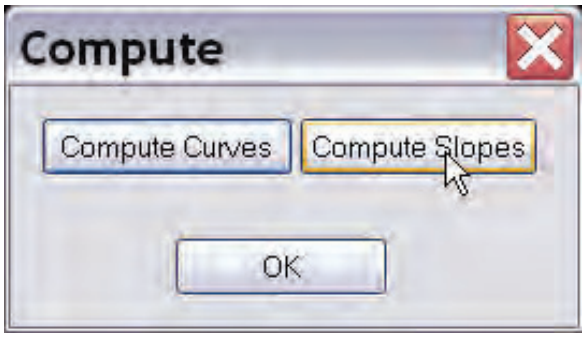


Figure 42. Recon info window

17. At this point, three options are available to the user. The options include:

    a. **View Complete Recon.** View the complete recon video by pressing "Play" [->]. The speed at which a video can be viewed can be selected from the top pull down menu in the "Recon Control" window. To accelerate the view, select x2, x3, etc. To slow down the video, select x1/2 or x1/4. The audio track collected during the reconnaissance can only be heard when the video is playing at x1 speed. After selecting the speed, press "Play" [->].

    b. **Skip to the next or previous road segment, road change, bridge, audio recording, etc.** Select the item of interest in the pull down menu in the "Seek" portion of the "Recon Control" window. Then, press "Next" [->>|] or "Previous" [|<<-]. The "Location" icon will jump to the selected item in the recon data. If the "Location" icon is not visible in the main map window, press "Play" [->] in the "Recon Control" window and the new location will be automatically centered in the main display window. This option is typically used when adding data to the "Route Database."

    c. **Save pictures displayed in the "Route:Picture" window.** While replaying the video, press "Pause" or "Stop" [||] in the "Route Control" window when the desired picture is shown in the "Route Picture" window (Figure 43). Move the mouse cursor into the "Route Picture" window and press the right mouse button. A "Save As" window will be displayed. Select a folder for the file and enter a file name; press "Save."

Figure 43. Saving still pictures

7 Creating a Route Database

Once all data have been added to the "Route Database," routes and route forms can be developed by following the following steps:

1. Expand the "Route Database" folder and double-click in the box to the left of "Roads." A check mark will appear in the box; the roads saved in the database will be displayed in the main display window as yellow lines.

2. Move the cursor to "Route Database" and press the right mouse button. Select "New Route" using the left mouse button; this will display the "New Route" window. Enter the desired name for the route and press "OK." Examples of possible names could be military designations or towns located on each end of the route.

3. A new category, "-Routes-," will be displayed under "Route Database." Expand the "-Routes-" category by clicking on the "+" sign to the left of the category; double click in the box next to the desired route. A toolbar will be displayed on the right side of the screen (Figure 44).

4. The default setting (color) for a route is a yellow line; change this setting so that it is different than the roads symbology. To change the symbol, press the "Edit Symbols" button  on the right side of the screen. The "Symbols" window will be displayed as shown in Figure 45. Select "Routes" from the pull down menu; then, press "Edit." The "Symbol Editor" window will be displayed. The color, pattern, and width of the line can be changed. Once the changes have been made, press "OK" on the "Symbol Editor" and "Symbols" windows.

5. To create a route, press "Add" on the right side of the screen, move the cursor over the road segment to be included in the route and press the left mouse button. The selected road segment will be displayed in the color selected for "routes."

6. To add additional road segments, move the cursor over the desired segment and click the left mouse button. The road segments must connect to the previously selected (or added) road segment to be included in the route. If the road segment does not connect to the previously added segment, an error stating "Segments Too Far Apart" will be displayed.

Figure 44. Displaying routes

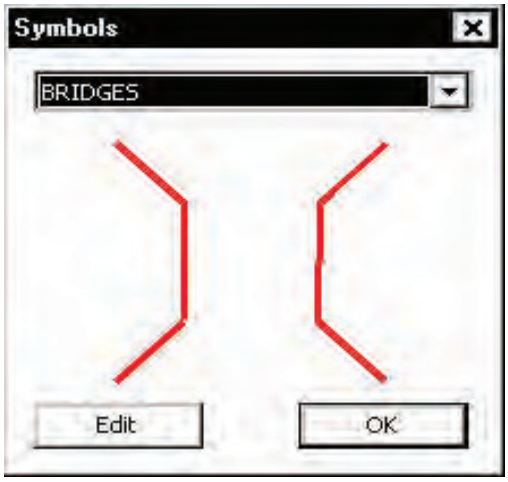


Figure 45. Symbols window

7. Zoom-in on the road segment area to be added to the route by using the zoom feature ; move the cursor to one corner of the desired "zoom" area, depress the left mouse button, and "drag" a "zoom-box" before releasing the mouse button.

8. Press the "Arrow" button and select the road segment immediately adjacent to the last segment added to the route. If there is a small gap between the two road segments, it will be necessary to add a new road segment.

9. To add a new road segment, highlight the "Road" category under the "Route Database" using the left mouse button. Select "New" from the toolbar on the right side of the screen. Move the cursor to the desired starting point of the new road segment and press the left mouse button; a square icon will appear at the point selected. Move the cursor to the next desired point in the road segment and press the left mouse button; a second square icon will appear. Continue this process until the last point is selected. After creating the last point, press "Done" on the toolbar at the top of the screen; the "Road Properties" window will be displayed. Add the known or estimated properties in the window and select "OK" (Figure 46). The new road segment will be created.

10. To continue constructing the route, highlight the desired route by using the right mouse button and selecting the next road segment(s).

11. To view the information for the newly created route, press the "Show Road Form" button on the right side of the screen. DA form 1248 will be displayed on the screen as shown in Figure 47. The form can be enlarged by moving the cursor to one side or corner of the form, depressing the left mouse button, and dragging the cursor to indicate the desired window size.

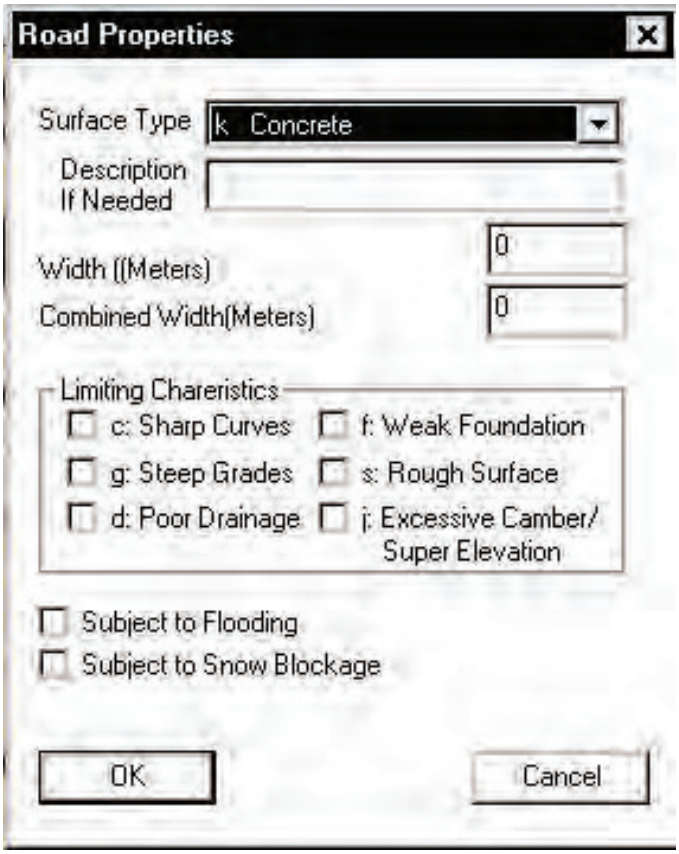


Figure 46. Road properties windows

The form can be moved in the display window by pressing the desired "Arrow" button along the top left hand corner of the "Route Form" window.

12. To view the second sheet of the "Route Form," select the "DA1248R" tab. Any box highlighted in yellow can be edited. The "Save As" button on the form allows the user to save the form as a "TIFF" or "BMP" file; each page is saved as a separate page. The "Print" button allows the user to print the form to a printer or to a PDF file, if Adobe® is installed on the computer.

13. Bridges, tunnels, points of interest, obstructions, etc. marked on the route will be displayed on the route reconnaissance form. Obstructions include

    a. Overhead obstructions such as tunnels, underpasses, overhead wires, and overhanging buildings with a clearance of less than 4.3 m.

    b. Reductions in traveled-way widths that are below the standard minimums prescribed for the type of traffic flow (see Table 1), including reductions caused by bridges, tunnels, craters, lanes through mined areas, projecting buildings, or rubble.

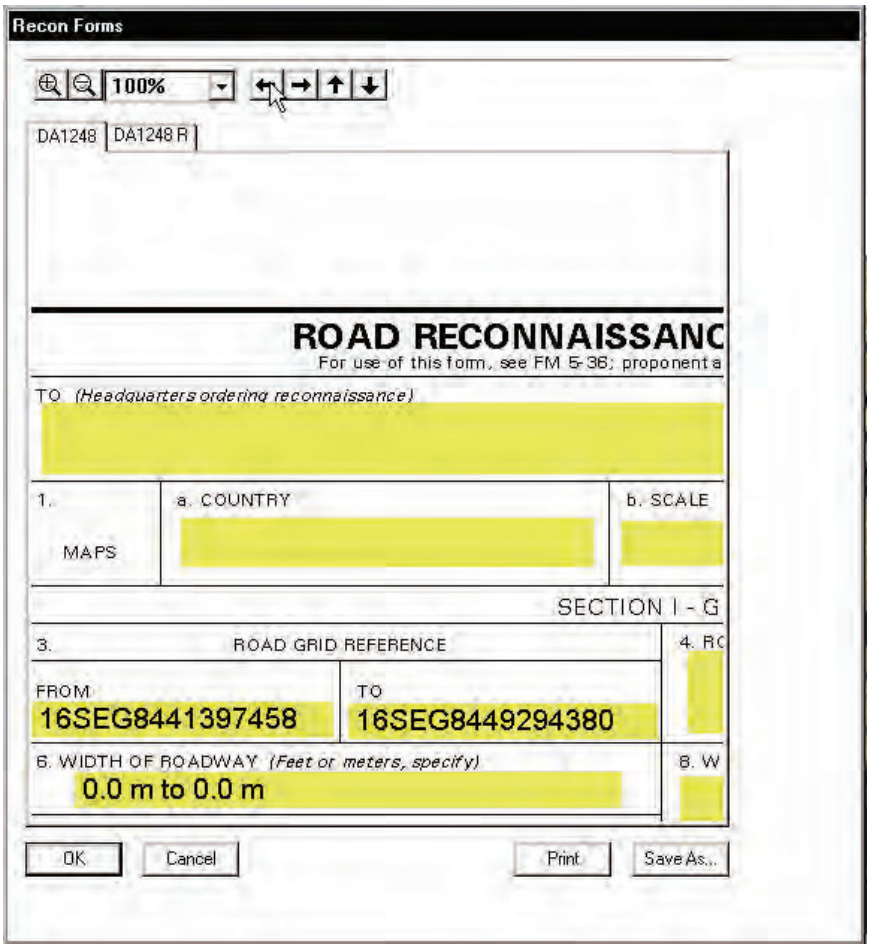


Figure 47. DA1248

c. Slopes (gradients) of 7 percent or greater.

d. Curves with a radius of 25 m and less. Curves with a radius of 25.1 to 45 m or greater are not considered to be an obstruction; however, they must be recorded on the route-recon overlay.

14. To transfer information from the "Route Database" to other systems, highlight the desired category by double clicking on it using the left mouse button; a check mark will be displayed in the box next to the category. Left click on the category and select "Export Shapefile" (from the "Bridges" category) or "Save As" (from other categories). Figure 48 provides an example. "Select Save As Shapefile Folder" will be displayed; select a folder where the shapefile will be saved. The file name for the exported file will become the name of the category. Three files will be created when data are exported: a ".dbf," a ".shp," and a ".shx" file. These files can be displayed in ArcView. If the data category is empty (i.e., bridge data doesn't exist and the user attempts to export the file) the system will potentially crash.

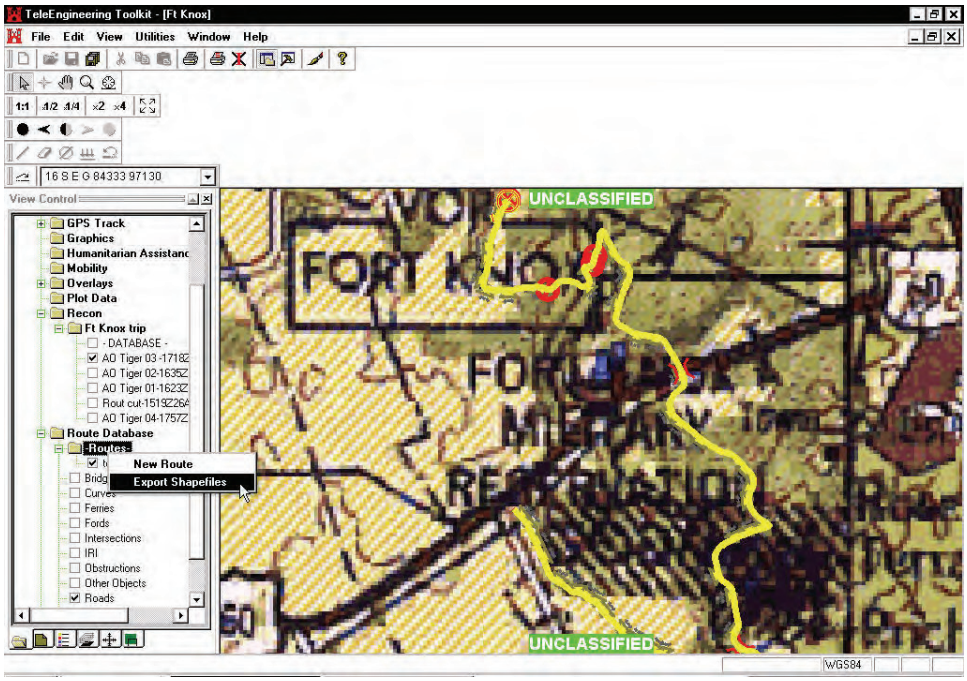


Figure 48. Exporting route database

8 Adding Data to a Route Database

Recon data can be processed in any order. Examples provided in this chapter describe the process.

1. Leave the “Recon:Control” window displayed on the screen, but move it to one side so that the main map/display window can be seen. Figure 49 demonstrates this action. The “Recon:Picture” window can be closed by clicking on the “X” located in the top right corner of the window. To display the “Recon:Picture” window again, ensure that the recon data file under “Recon” is highlighted and select “Show Recon View Form.” The “System Control” window along the bottom of the display screen can also be closed at this time by pressing the “System Control” button  at the top of the display window.

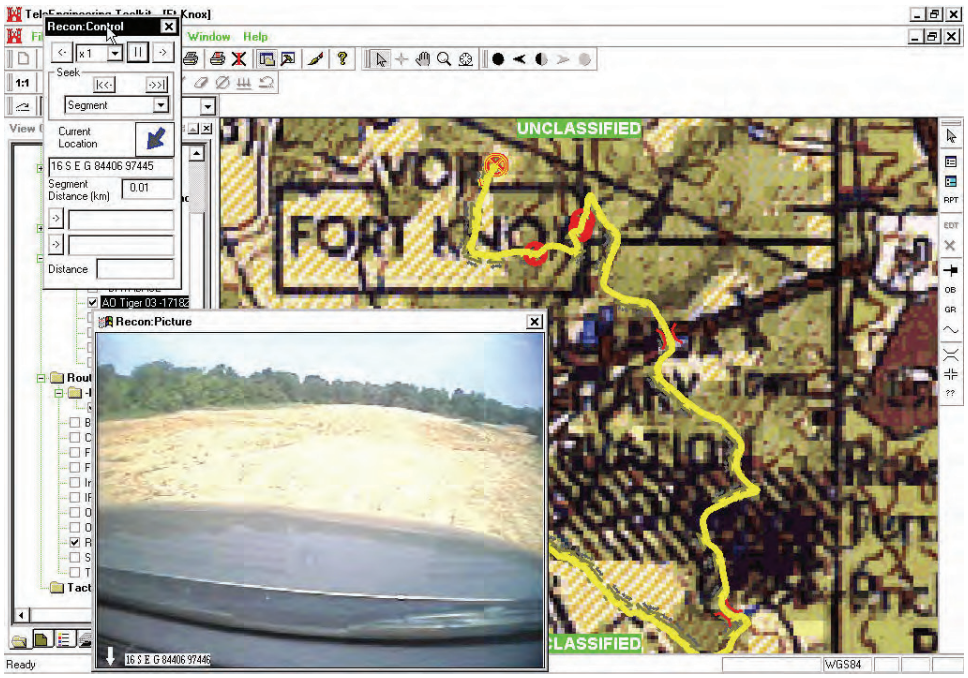


Figure 49. Moving the Recon:Control window

2. Expand the “Route Database” by clicking on the “+” symbol to the left of it; this will display all categories in the “Route Database.”

3. Double click on the “Roads” category. A check mark will be displayed in the box to the left of “Roads”; roads saved in the database will be displayed on the screen. There should be a road segment overlaid on the route recon data displayed. If a road is not displayed over the route recon data, that data may not have been successfully transferred to the database. See steps 12 - 14 from Chapter 7 for instructions on transferring data.

4. Press “Play”  in the “Route:Control” window and listen to the starting description of the roadway. Headphones should be used to listen to the audio to ensure that all levels of audio are audible. **NOTE**: To listen to the audio, the playback speed must be set to “x1.” After listening to the initial audio, press “Stop”  .

5. Select the “Roads” category in the “Route Database” by clicking once on “Roads” with the left mouse button. A toolbar should now be visible on the right side of the display screen. Press the “arrow” button  on the toolbar; then, select the initial portion of the road. A white line will appear on the selected road segment.

6. Press “ATT” on the toolbar to edit road segment information. A “Road Properties” window will be displayed as shown in Figure 50.

7. Select the road surface type from the pull-down menu and enter any desired description of the roadway.

8. Enter the width of the travel-way in meters in the box labeled “Width.” For two-lane roads with no median or dividers, the width entered should be the entire width of both lanes.

9. Enter the total width of the roadway (in meters) in the box labeled “Combined Width.” This width includes the width of the travel-way plus the width of the shoulder(s), if present.

10. Select any limiting characteristics present on that segment of roadway; then, press “OK.”

11. Move the cursor to the “Recon:Control” window and select “Sound” from the “Seek” pull down menu. Press “Next”  ; the “Location” icon will automatically move to the next area where audio was recorded. Press “Play”  and listen to the audio recording. After listening to the information, press “Stop”  .

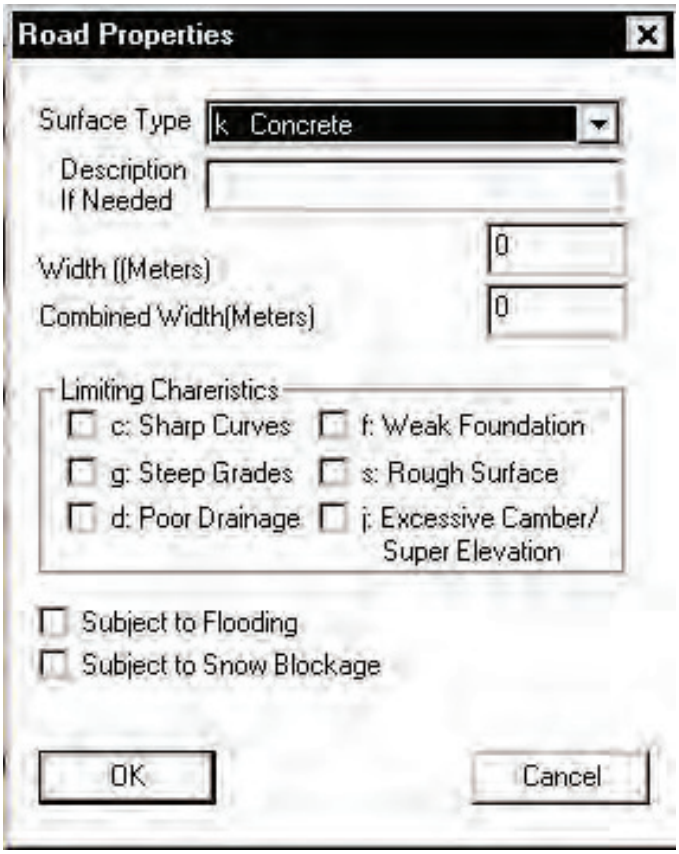


Figure 50. Road properties window

12. Select the category verbally described in the audio recording from the "Recon Database." For example, if the audio describes a bridge, double click (check) the box next to "Bridges." All bridges saved in the database in the area of interest will be displayed (Figure 51).

13. If a bridge icon is not displayed at that location, press "New" on the toolbar on the right side of the display. The cursor will change to cross hairs when "hovering" over the main display window. Move the cursor to the location of the bridge (usually the center of the "Location" icon) and click the left mouse button; the Bridge Reconnaissance Report will be displayed. Add collected bridge data to the form and press "OK"; a bridge icon will be displayed at that location.

14. If a bridge icon is displayed at the location, press the "arrow" button , move the cursor to the desired bridge icon, and select it with the left mouse button. Select the "ATT" button from the toolbar and the Bridge Reconnaissance Report form will be displayed. Enter the information collected and press "OK." Figure 52 provides an example of the bridge reconnaissance report form.

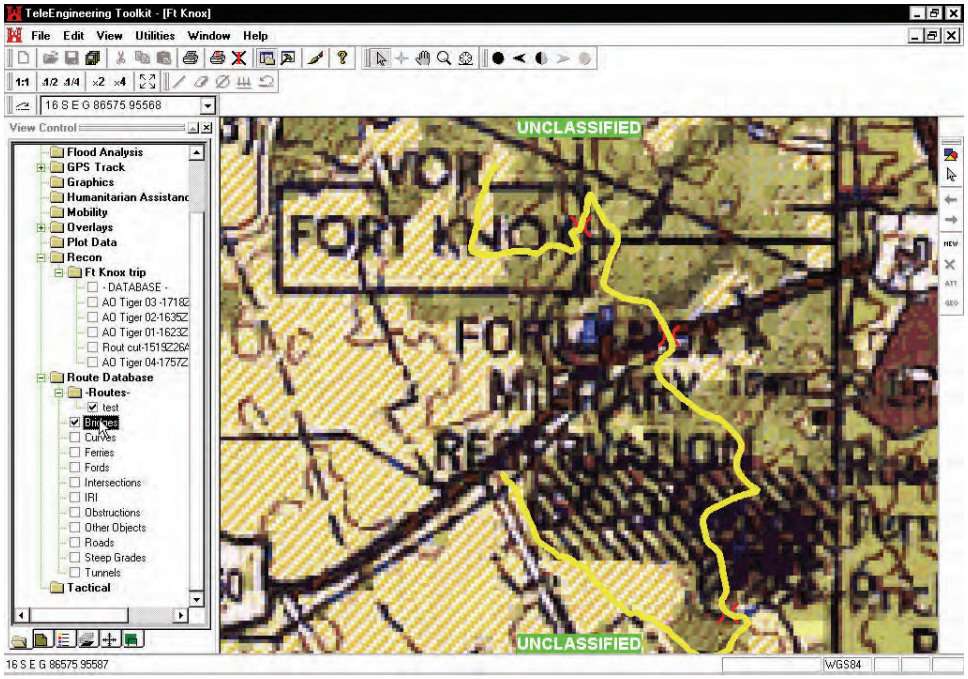


Figure 51. Selecting bridges

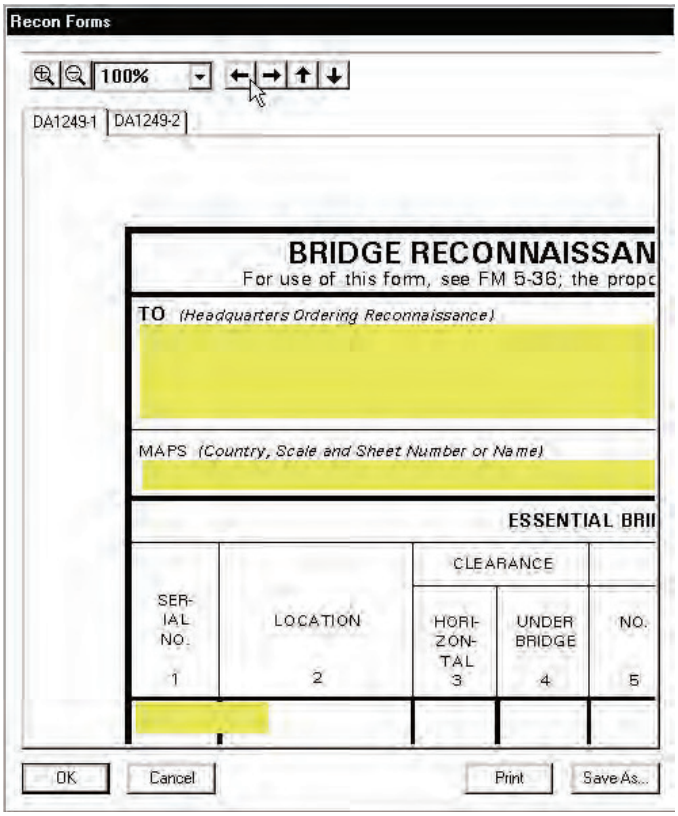


Figure 52. Example of Bridge Reconnaissance Report form

15. The location of the bridge can be changed; select the bridge by pressing the "arrow" cursor and then pressing the "GEO" button on the toolbar. The cursor will change to cross hairs when hovering over the main display window. Move the cursor to the desired location and click the left mouse button; the bridge icon will move to the newly selected location.

16. To delete a bridge (or item) from the database, select it using the "arrow" cursor; then, press the "X" on the toolbar on the right side of the screen.

17. To change the icon used for a bridge (or item), highlight a category in the "Route Database" and press the "Edit Symbols" button  on the toolbar. The "Symbols" window will be displayed; the desired object can be selected from the pull-down menu.

18. Press the "Next" button on the "Recon:Control" window, thus moving the "Location" icon to the next audio recording and listen to the audio. Press the "Stop" button; highlight the desired category from the "Route Database." Next, edit the exiting item at that location or add a new item at that location and enter its description. Continue this process until the end of the recon data is reached.

9 Adding a Map from Data to the Route Database

Route reconnaissance data can be added to the Route Database for additional analysis. In addition to adding data from route reconnaissance missions, data can be added to the database using "map reconnaissance" techniques for planning purposes.

The phrase "map reconnaissance techniques" implies that the information added to the Route Database is accomplished by "tracing" roadways or adding tunnels, bridges, fords, and/or ferry sites from the map display used in the Toolkit instead of basing the information on data actually collected using the ARRK. Data are added by expanding the "Route Database," selecting the desired object to be added, and pressing the "New" button on the toolbar. More detailed instructions are provided in Chapter 7 of this manual and in the Toolkit user's manual.

10 Creating a Final Product

Images, audio, and data collected during a recon can be used to create presentations through mediums such as PowerPoint®. Although no official endorsements are provided herein, this chapter provides guidance on presenting collected data and example presentations. Figure 53 presents an example PowerPoint® slide showing a segment of a route and including an AVI.

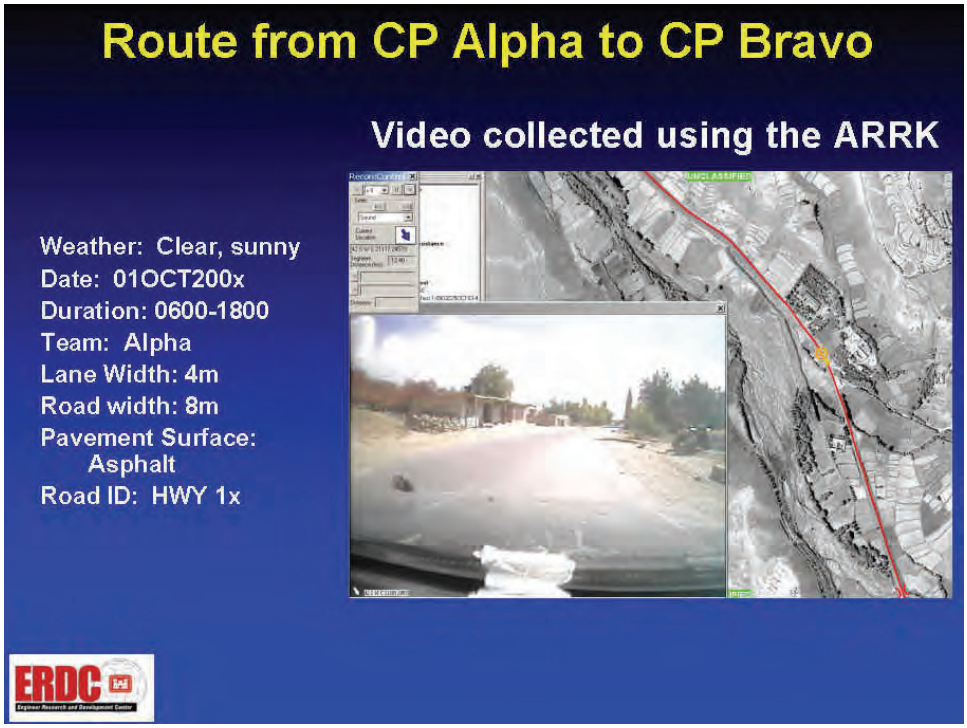


Figure 53. Example slide

The AVI was collected while playing back the audio and video collected during a recon. A screen capture tool was used to capture the video and save it as an AVI; then, the AVI was "inserted" into the slide. Relevant information including a route name, team that conducted the recon, date, time, surface description, road description, and weather conditions are listed on this example slide. The slide presented in Figure 53 is simply an example demonstrating the potentially powerful use of ARRK products in reports and presentations.

For more details, contact the TeleEngineering Operations Center for assistance. Contact information is provided in Chapter 11.

11 Technical Support

If you need support, contact the TEOC at one of the following numbers:

(601) 634-2735 (Commercial)
(312) 446-2735 (DSN)

Questions may be emailed to the TEOC at

teoc@usace.army.mil (nonsecure)

teoc@teleengineering.army.smil.mil (secure)

You may visit our Web sites at

https://teleengineering.usace.army.mil (nonsecure)

http://teleengineering.army.smil.mil (secure)

References

Headquarters, Department of the Army. (1998). “Engineer reconnaissance,” Field Manual 5-170 (5 May 1998; chg 1, 13 Jul 1998), Washington, DC.

Williamson, Jeffrey L., and Lynch, Larry N. (2003). “Installation and use of the TeleEngineering Toolkit,” U.S. Army Engineer Research and Development Center, Vicksburg, MS.

Appendix A
Quick Start Instructions

Appendix A provides a summary of instructions presented in Chapter(s) 3 through 9. If this is your first time to use the ARRK or if you would like more detail, refer to the steps presented in Chapters 3 through 9.

Installation of the ARRK in a vehicle.

1. Connect the appropriate cables to the Laptop (see Figure A1).

    a. Connect the USB connector, AC power, and PCMIA card from the umbilical cord to the laptop.

    b. Connect the microphone to the laptop.

    c. Connect the event marker/record toggle to COM port 1 on the back of the laptop.

Figure A1. Laptop connections

2. Connect the appropriate cables to the sensor box (see Figure A2).

    a. Connect the military connector end of the umbilical cord to the sensor box.

    b. Connect the power cable to the sensor box (a NATO slave cable is used for military vehicles and a cigarette AC adapter cable is used for commercial vehicles).

    c. Connect the GPS cable to the sensor box and GPS **(DO NOT TURN-ON THE GPS UNTIL AFTER THE COMPUTER HAS BEEN TURNED-ON.** Failure to do this can cause the laptop computer to function erratically).

d. Connect the external GPS antenna to the GPS and place the external antenna on the roof of the vehicle.

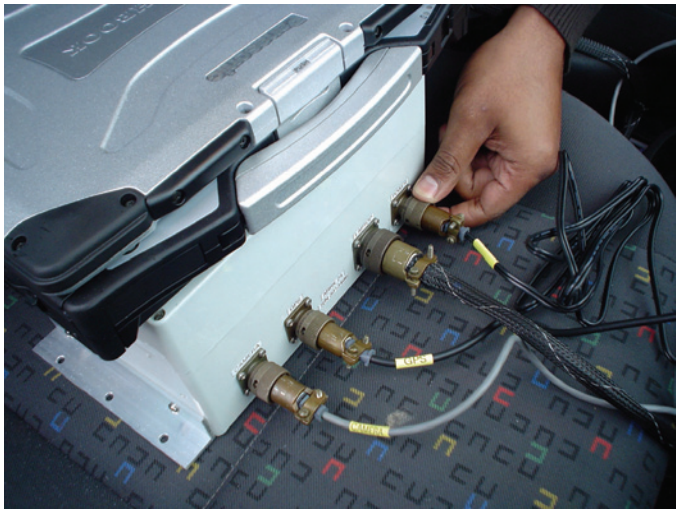


Figure A2. Sensor box connections

e. Connect the camera cable to the sensor box and affix the camera to the windshield (a 90-deg mounting plate is provided for HMMWVs and a 45-deg mounting plate is provided for commercial vehicles).

3. Place the sensor box on the rear floorboard and secure it to the vehicle (the cable connections should be facing the rear of the vehicle). Mounting screws are provided to secure the sensor box to the vehicle, but a sandbag can be placed on top instead of using the screws.

4. Turn-on the laptop and enter the user ID and password.

5. Open the Toolkit software by double-clicking the red castle icon on the desktop. On some computers, the Toolkit icon will be a red and black square.

6. Turn-on the GPS by pressing the red button. If this is the first time you have operated the GPS or it is a replacement, you will need to initialize the settings by:

   a. Turn-on GPS and allow it to power-up.

   b. Press PAGE several times until you see the MAIN MENU screen.

   c. Select the SETUP MENU.

   d. Select the INTERFACE.

   e. Ensure the GPS is scrolled to NMEA/MMEA on the top line.

f. Ensure the baud rate is set at 4800.

g. Press PAGE several times until you hit the ACQUIRING EPE page and select the country location.

7. The Toolkit now has to be set up to collect data.

Setting up the Toolkit Software for a Route Recon

1. Ensure the screen saver is turned-off on the laptop.

2. Open an existing project or create a new project as explained in the Toolkit user's manual.

3. Expand the project by clicking on the "+" symbol to the left of the project name.

4. Display a map background in the display window.

5. Select the "Project" tab in the lower left portion of the screen to show the project information again.

6. Right click on the "Recon" directory and select "New Database."

7. Type in the desired name for the recon data and select the path to save the recon data. Press "OK."

8. Expand the "Recon" directory by clicking on the "+" symbol next to it. The name of the recon data should be displayed.

9. Right click on "named" recon and select "Record Recon" from the list to display a "Record Data" window. Select "OK" and the "Record" window will be displayed.

10. Select the "Output control" icon (looks like a small hammer in a window) from the top of the Toolkit screen or by selecting "View" and "Output Control." The output from the camera should be displayed on the left hand portion of the "Output Control" window. A line graph should be displayed on the right hand portion of the lower screen. Move the mouse cursor to the line graph area and click the right mouse button to display the "Graph Control" window. In the pull-down boxes, the words "records," "Sound," and "Z-Acc" should be displayed. Change the color of the items displayed, if desired. Close the "Graph Control" box by clicking on the "X."

11. If the system is configured properly, the view from the camera should be visible on the lower left portion of the screen and a small camera and GPS icon should be visible on the lower right portion of the screen. The camera and GPS icons will be at the bottom of the data collection

chart and will be scrolling from right to left. The Z-acceleration data should also be visible, but may be barely visible. A yellow and red circle with an arrow pointing from it should also be displayed in the map window, indicating the current location and direction as determined from the GPS.

12. Press the event mark toggle and talk into the microphone. The audio data should be visible on the lower right portion of the screen.

13. If all data are visible, the system is ready to record data; otherwise, press the "SETUP" button from the recorder box.

14. The default readings in the "Recorder Setup" window should be:

    a. Camera – Belkin USB (352X288).

    b. Seconds/Frame – 2.5.

    c. Compression Quality – 70.

    d. GPS Port – COM 4 (for CF29)/COM 5/COM 6.[1]

    e. GYRO Port – COM 3 (for CF29)/COM 6/COM 7.[1]

    f. On – checked.

    g. Accel Pkg – 10 g.

    h. Sound Button Port – COM 1.

    i. IRI-ACC On – Unchecked (this may not be available on your system).

15. If the system is not working with these settings, refer to Chapter 4 for more suggestions.

16. If you entered "Setup," select the "OK" button. The system should now be ready to record recon data.

Conducting a Route Recon

The exact procedures used in conducting a reconnaissance will depend on the mission. The user is referred to FM 5-170 for the tactics, techniques, and procedures for conducting a reconnaissance mission.

1. Now that the system is configured to collect recon data, measure the pavement lane width and total width.

[1] Should be labeled on keyboard of Toughbook laptop.

2. Press the record button and begin driving the designated route.

3. Depress the event mark toggle and speak into the microphone to record the starting time, weather conditions, name of the road, the lane width, the total width, and the pavement type. Once the audio data has been recorded, release the event marker toggle.

4. Continue driving the route and identify the items of interest by pressing the event marker toggle and speaking into the microphone or selecting the correct item from the list in the "Recorder" window. Identify the item by selecting it from the list and recording audio data describing information concerning the items. Recommended items are bridges, overhead obstructions, intersections, road-type changes, constrictions, sharp curves, and steep slopes.

5. When completed with the recon, press "STOP." This will end the data collection and a file name will appear in the left hand side of the Toolkit screen. The file name will contain the name that was typed in at the beginning of the recon plus a time-date stamp of when the recon was started.

6. To view the completed recon, double click in the box area next to the desired file.

It is recommended that the recon data collection be stopped about every 4 hr and a new file started to prevent the file size from becoming too large.

Viewing the Recon Data and Calculating Slopes, Curves, and the International Roughness Index

These instructions assume that you are processing data on the same computer on which it was collected.

1. Open the Toolkit project containing the recon data.

2. Expand the project files by selecting the "+" sign on the left side of the project name.

3. Display a map background in the display window.

4. Select the "Project" tab in the lower left portion of the screen to show the project information again.

5. Expand the "Recon" folder by selecting the "+" sign on the left side of the folder. The subfolder used to collect the recon data should now be displayed.

6. Expand the desired recon subfolder by selecting the "+" sign next to it. The word "DATABASE" and the collected recon files should be

visible. Double click in the box to the left of the desired recon file. A check mark will appear in the box and the data should appear in the window on the right hand side of the screen.

7. If the data are not displayed in the screen, click on the "Show Recon View Form" button on the far right-hand side of the screen. This will produce a "Recon:Picture" window and a "Recon:Control" window.

8. Click on the "Play" button in the "Recon:Control" window. Once the "Play" button is selected, the recon video will start playing and the recon data will be automatically centered in the main display or map window. Press the "Pause" or "Stop" button (the button with two parallel lines on it) to stop the video.

9. To zoom-in on the data, use the "Magnifying Glass" icon along the top of the screen.

10. Select the "Edit Recon Properties" button (the second button down vertically) from the toolbar on the right-hand side of the screen. The "Recon Info" window will be displayed.

11. Select the **"Compute Curves"** button, then the **"Compute Slopes"** button, and lastly the "**Compute IRI**" button. (**NOTE**: the IRI calculation is not operational on all versions of the Toolkit and ARRK.) If there are any sharp curves or steep slopes, they will be displayed along the recon trace in the main display window. **This step should only be conducted once for each of the recon data files**.

12. Right click on the activated (highlighted) recon file under the Recon Folder on the left side of the screen (i.e., the one that was just used to calculate curves and slopes) and select **"Save Objects (Engr Db)"** from the list to add the collected recon to the Engineering Route Database. **This step should only be conducted once for each of the recon data files.**

13. Ensure the "Location" icon (the yellow and red circle with an outward pointing arrow) is visible at the beginning of the route recon data by selecting "Segment" from the pull down menu in the "Seek" portion of the "Recon Control" window. Then click on the "Previous" button, to the left just above the "Segment" pull-down menu.

14. Several options are now available to the user. The options include:

    a. View the complete recon video.

    b. Skip to the next or previous road segment, road change, bridge, audio recording etc.

    c. Save pictures displayed in the "Route:Picture" window.

Adding Data to the Route Database

Recon data can be processed in any order that the user desires. The examples provided in this section are to make the user aware of the process that can be used.

1. Leave the "Recon:Control" window displayed on the screen but move it to one side so that the main map/display window can be seen. The "System Control" window along the bottom of the display screen can also be closed at this time by selecting the "System Control" icon (the icon with a hammer in it) from the top of the display window.

2. Expand the "Route Database" by clicking on the "+" symbol to the left of it. This will display all of the categories that are in the "Route Database."

3. Double click on the "Roads" category. If a road is not displayed over the route recon data, then that data may not have been transferred to the database. See steps 10 – 12 from the above section.

4. Press the "Play" button in the "Route:Control" window and listen to the starting description of the roadway using the headphones.

5. Select the "Roads" category in the "Route Database" by single clicking on "Roads" with the left mouse button. Select the "arrow" icon from the toolbar and then select the initial portion of the road to display the selected road.

6. Select the "ATT" icon from the toolbar to edit the information on the segment of road to display in the "Road Properties" window.

7. Select the road surface type from the pull-down menu and enter any desired description of the roadway.

8. Enter the width of the travelway in meters into the box labeled "Width." Enter the total width of the roadway in meters into the box labeled "Combined width."

9. Select any limiting characteristics that may have been present on that segment of roadway and then press "OK."

10. Move the cursor to the "Recon:Control" window and select "Sound" from the "Seek" pull-down menu. Press "Next" and the "Location" icon will automatically move to the next area where audio was recorded. Press "Play" and listen to the audio recording. After listening to the information, press "Stop."

11. Select the category described in the audio from the "Recon Database." For example, if the audio describes a bridge, double click in the box next to "Bridges."

12. If no bridge icon is displayed at that location, select the "New" button from the toolbar on the right-hand side of the display. Move the cursor to the location of the bridge (usually the center of the "Location" icon) and click the left mouse button. Add as much data as was collected on the bridge into the bridge recon form and press "OK."

13. If bridge icon is displayed at the location, select the "arrow" icon, move the cursor to the desired bridge and select it with the left mouse button. Select the "ATT" button from the toolbar; enter the information collected into the bridge recon report and press "OK."

14. The location of the bridge can be changed by selecting the bridge using the "arrow" icon and then selecting the "GEO" button from the toolbar. Move the cursor to the desired location and click on the left mouse button to move the icon to the new location.

15. To delete a bridge (or item) from the database, select it using the "arrow" icon and then select the "X" button from the toolbar on the right side of the screen.

16. To change the icon used for a bridge (or item), highlight one of the categories in the "Route Database" and select the "Edit Symbols" icon from the toolbar on the right-hand side of the screen. Select the desired object from the pull-down menu.

17. Press "Next" on the "Recon:Control" window, thus moving the "Location" icon to the next audio recording and listen to the audio. Press "Stop" and highlight the desired category from the "Route Database." Next, edit the existing item at that location or add a new item at that location and enter its description. Continue this process until the end of the recon data is reached.

Creating a Route Using the Route Database

1. Once all data have been added to the "Route Database," routes and route forms can be developed.

2. Expand the "Route Database" folder and double-click in the box to the left of "Roads" to display the roads as yellow lines.

3. Move the cursor to "Route Database" and press the right mouse button. Select "New Route" using the left mouse button. Type in the desired name for the route and press "OK."

4. A new category, "-Routes-," will be displayed under the "Route Database." Expand the "-Routes-" category by clicking in the "+" sign to the left of the category and double click in the box next to the desired route.

5. The default setting for a route is a yellow line. It is recommended that this be changed so that it is different than the roads symbology.

6. To create a route, select "Add" from the right side of the screen, move the cursor over the road segment to be included in the route, and press the left mouse button.

7. To add additional road segments, move the cursor over the desired segment and click the left mouse button. The road segments must connect to the previously selected (or added) road segment to be included in the route. If the road segment does not connect to the previously added segment, an error stating "Segments too far Apart" will be displayed.

8. Zoom-in on the road segment area that is to be added to the route.

9. Select the "Arrow" icon and then select the road segment immediately next to the last segment added to the route. If there is a small gap between the two road segments, it will be necessary to add a new road segment.

10. To add a new road segment, highlight the "Road" category under the "Route Database" using the left mouse button. Select "New" from the toolbar on the right-hand side of the screen. Move the cursor to the desired starting point of the new road segment and press the left mouse button. A square icon will appear at the point selected. Move the cursor to the next desired point in the road segment and press the left mouse button. A second square icon will appear. Continue this process until the last point is selected. After creating the last point, select the "Done" icon. Add the known or estimated properties in the "Road Properties" window and press "OK" to create the new road segment.

11. To continue constructing the route, highlight the desired route by using the right mouse button and selecting the next road segment(s).

12. To view the information for the route that has been created, select the "Show Road Form" button. DA Form 1248 will be displayed on the screen.

13. To view the second sheet of the "Route Form" select the DA1248R tab. Any item that is highlighted in a yellow box can be edited. The "Save As" button on the form allows the user to save the form as a "TIFF" or "BMP."

14. Bridges, tunnels, points of interest, obstructions, etc. that are along the route will be displayed on the route reconnaissance form.

15. To transfer information from the "Route Database" to other systems, highlight the desired category. Left click on the category and select "Export Shapefile" or "Save As." The "Select Save As Shapefile Folder" will be displayed. Select the folder where the shapefile will be

saved; the file name for the exported file will be the name of the category. Three files will be created: a dbf, a shp, and a shx file.

Adding Data to the Route Database

All route reconnaissance data are added to the Route Database for additional analysis. In addition to adding data from route reconnaissance missions, data can be added to the database using "map reconnaissance" techniques for planning purposes. Refer to Chapter 9 for details.

Appendix B
Bridge Reconnaissance Requirements

Guidance provided in Appendix B is intended to supplement guidance provided in FM 5-170.

Recommendations presented here in Appendix B summarize data and information critical to accurately assess and classify bridges. A PowerPoint® version of Appendix B is available by contacting TEOC.

Bridge Reconnaissance Requirements
For TeleEngineering

Table of Contents

Page 1

Introduction

This field guide is provided to facilitate adequate data exchange for bridge assessment support through TeleEngineering. It's purpose is not to replace, but to supplement the field reconnaissance guidelines of FM5-36 "Route Reconnaissance and Classification" and the analytical guidelines of FM5-446 "Military Nonstandard Fixed Bridging".

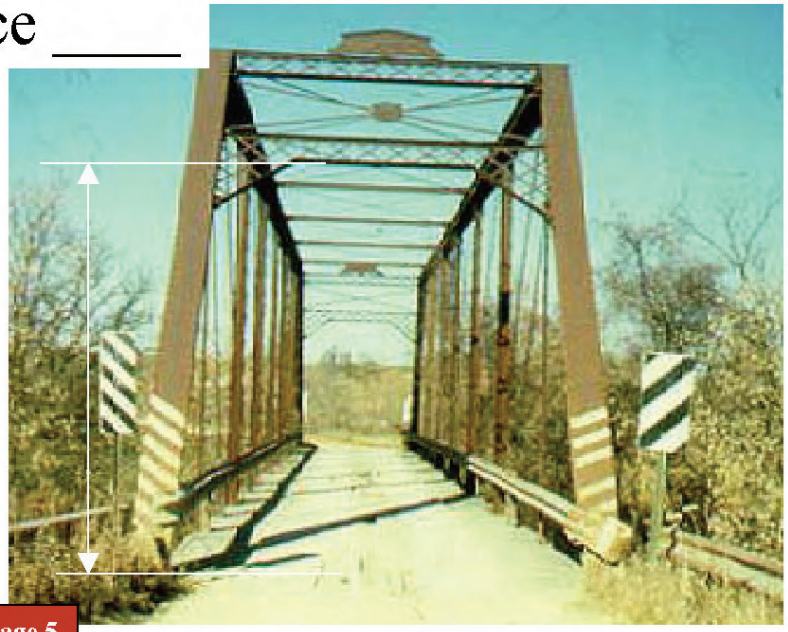
Please review the following pages and whenever possible, provide reconnaissance data as requested on these pages.

Try to use this terminology if possible.

Common Terminology

Deck
Direction of Traffic
Stringer
(Spans between floor beams)
Girder
(Spans substructure to substructure)
Floor Beam
(Spans between girders)
Main Girder
Stringer
Floor beam
Floor beam
Page 4
Common Superstructure Terminology

Minimum overhead clearance _____



If less than 4.3 meters – posting is required.
Enter ∞ for unlimited.
Enter ? For unknown.

Page 5

Measured .3 meters above road surface.

For trusses it is measured 1.21 meters above the surface.


Under bridge clearance _____
Page 7
Underside of span
to water surface

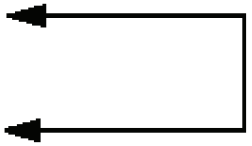
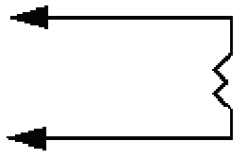
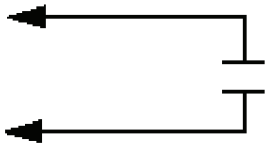
Bypass Data

Along route picture

Elevation picture

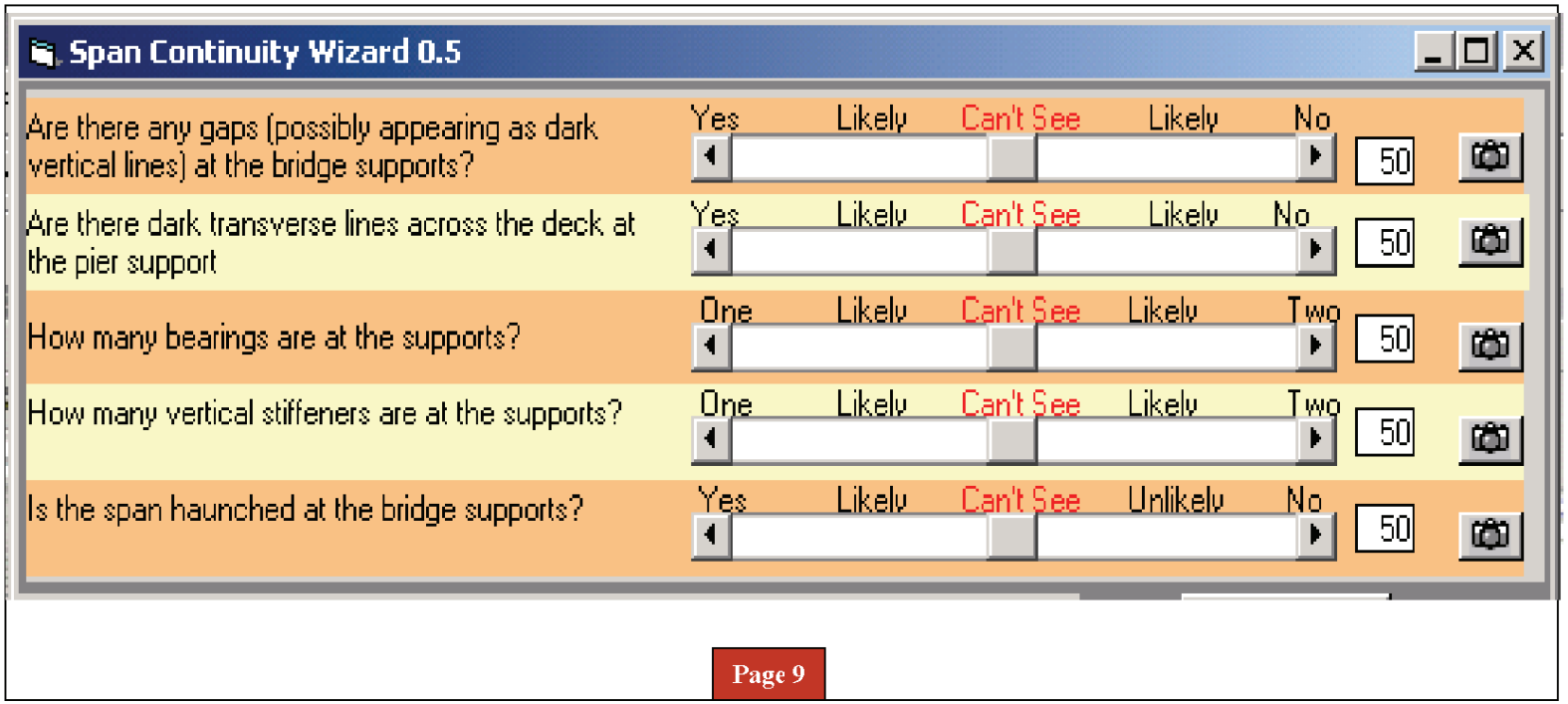
Under bridge clearance

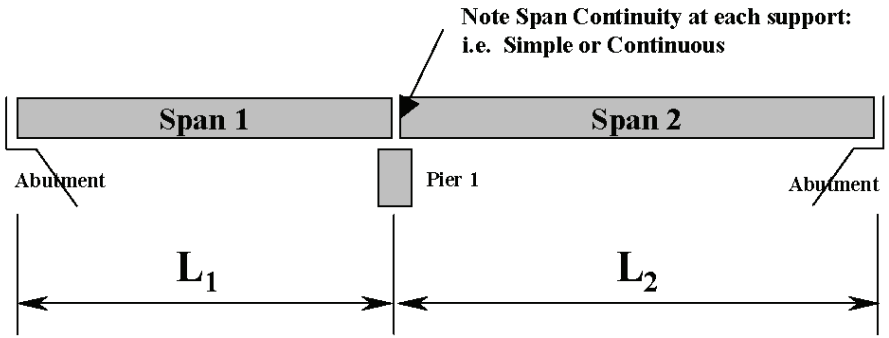
Bridge length

	Bypass easy. Use when the obstacle can be crossed in the immediate vicinity by a US 5-ton truck without work to improve the bypass.
	Bypass difficult. Use when the obstacle can be crossed in the immediate vicinity, but some work to improve the bypass is necessary.
	Bypass impossible. Use when the obstacle can be crossed only by repairing or constructing a feature or by detouring around the obstacle.

-Theater Commander consider it unacceptable to dismount the HET

Page 8


Span Continuity Wizard 0.5
Are there any gaps (possibly appearing as dark vertical lines) at the bridge supports?
Yes Likely Can't See Likely No
50
Are there dark transverse lines across the deck at the pier support
Yes Likely Can't See Likely No
50
How many bearings are at the supports?
One Likely Can't See Likely Two
50
How many vertical stiffeners are at the supports?
One Likely Can't See Likely Two
50
Is the span haunched at the bridge supports?
Yes Likely Can't See Unlikely No
50
Page 9



- For each bridge, provide a side view sketch of all spans as shown above, along with a good photo if possible.
- Then provide a sketch of each span's cross-section as shown on the following pages.

Page 10

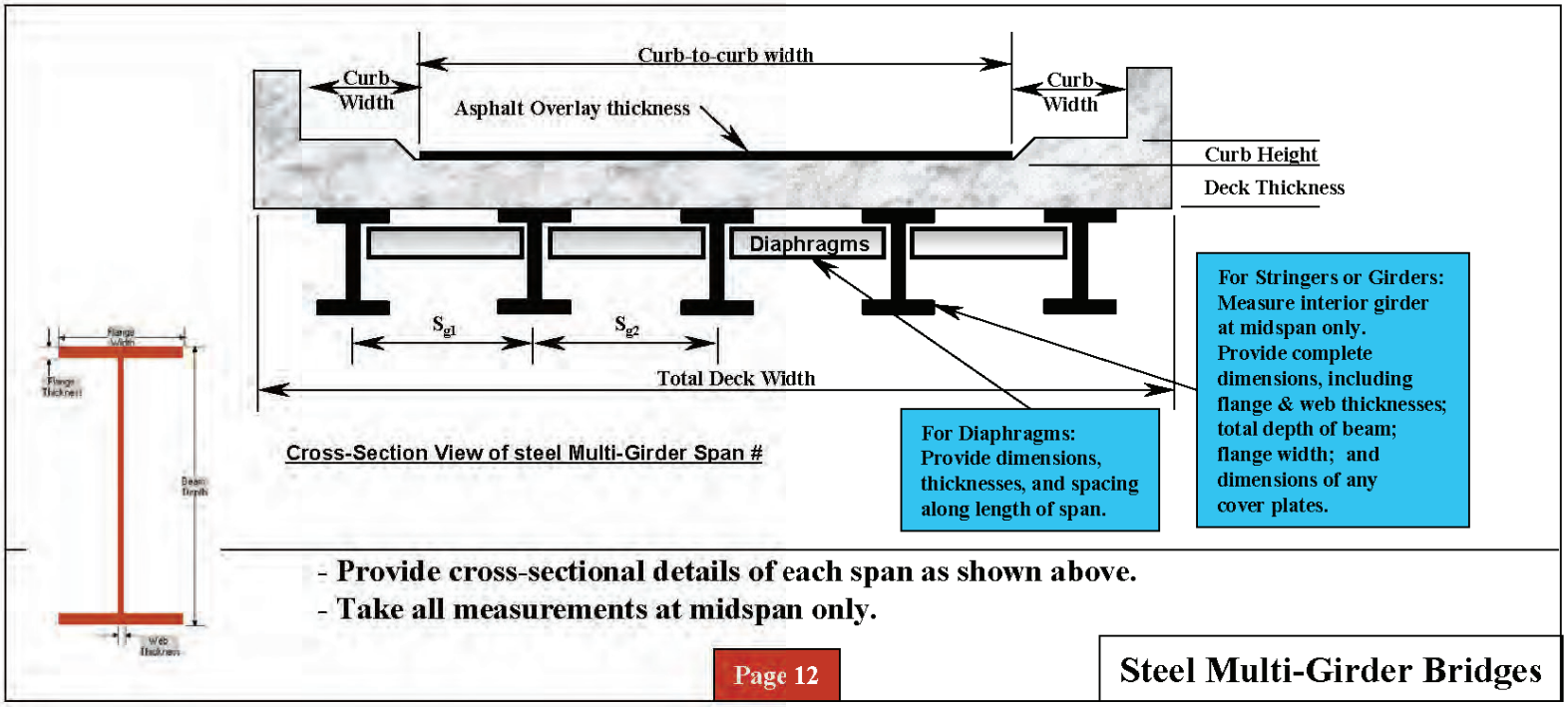
Side View of all Bridges

Side View

Underside View

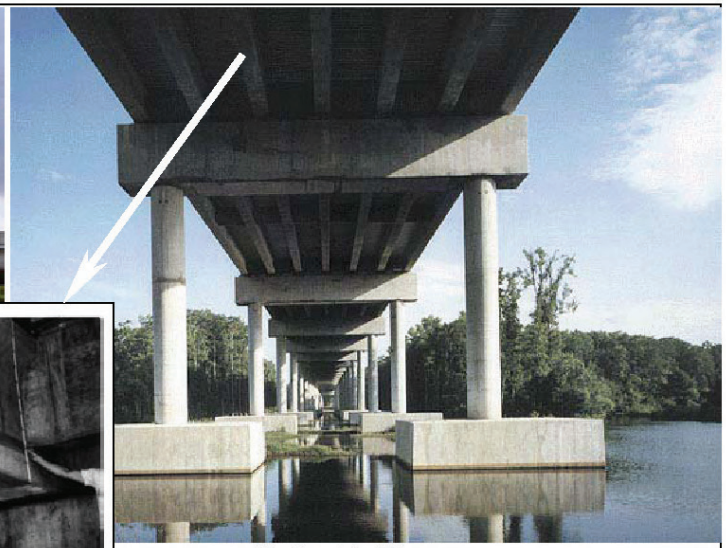
Page 11

Steel Multi-Girder Bridges


Curb-to-curb width
Curb Width
Asphalt Overlay thickness
Curb Width
Curb Height
Deck Thickness
Diaphragms
S_{g1}
S_{g2}
Total Deck Width
Cross-Section View of steel Multi-Girder Span #
For Diaphragms: Provide dimensions, thicknesses, and spacing along length of span.
For Stringers or Girders: Measure interior girder at midspan only. Provide complete dimensions, including flange & web thicknesses; total depth of beam; flange width; and dimensions of any cover plates.
- Provide cross-sectional details of each span as shown above.
- Take all measurements at midspan only.
Page 12
Steel Multi-Girder Bridges

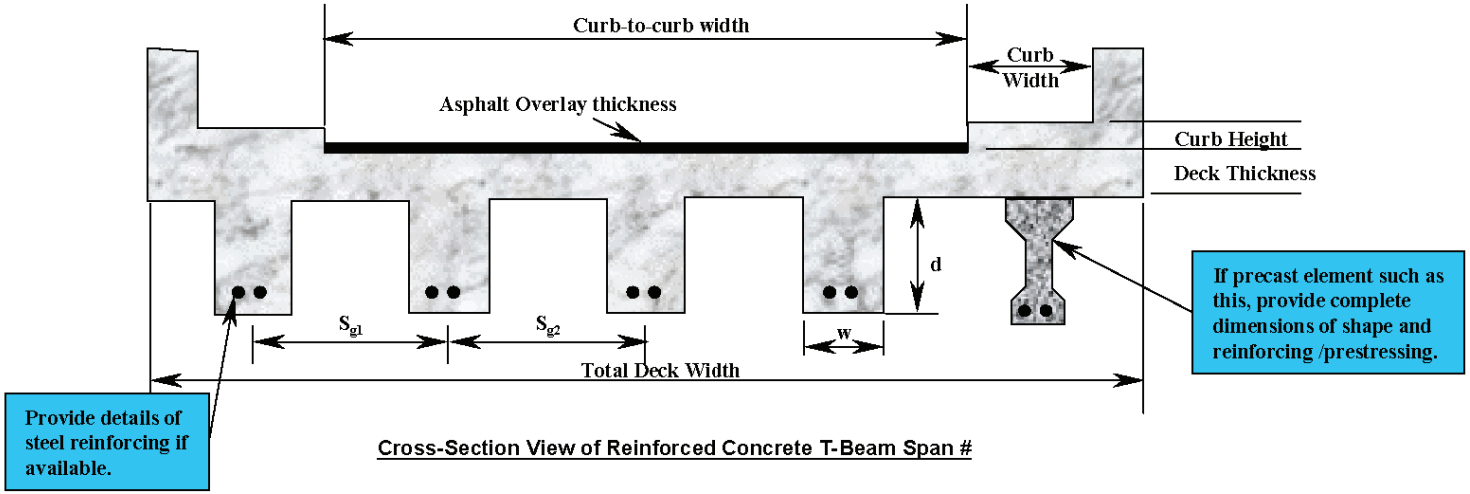
Side View

Girder Close-up

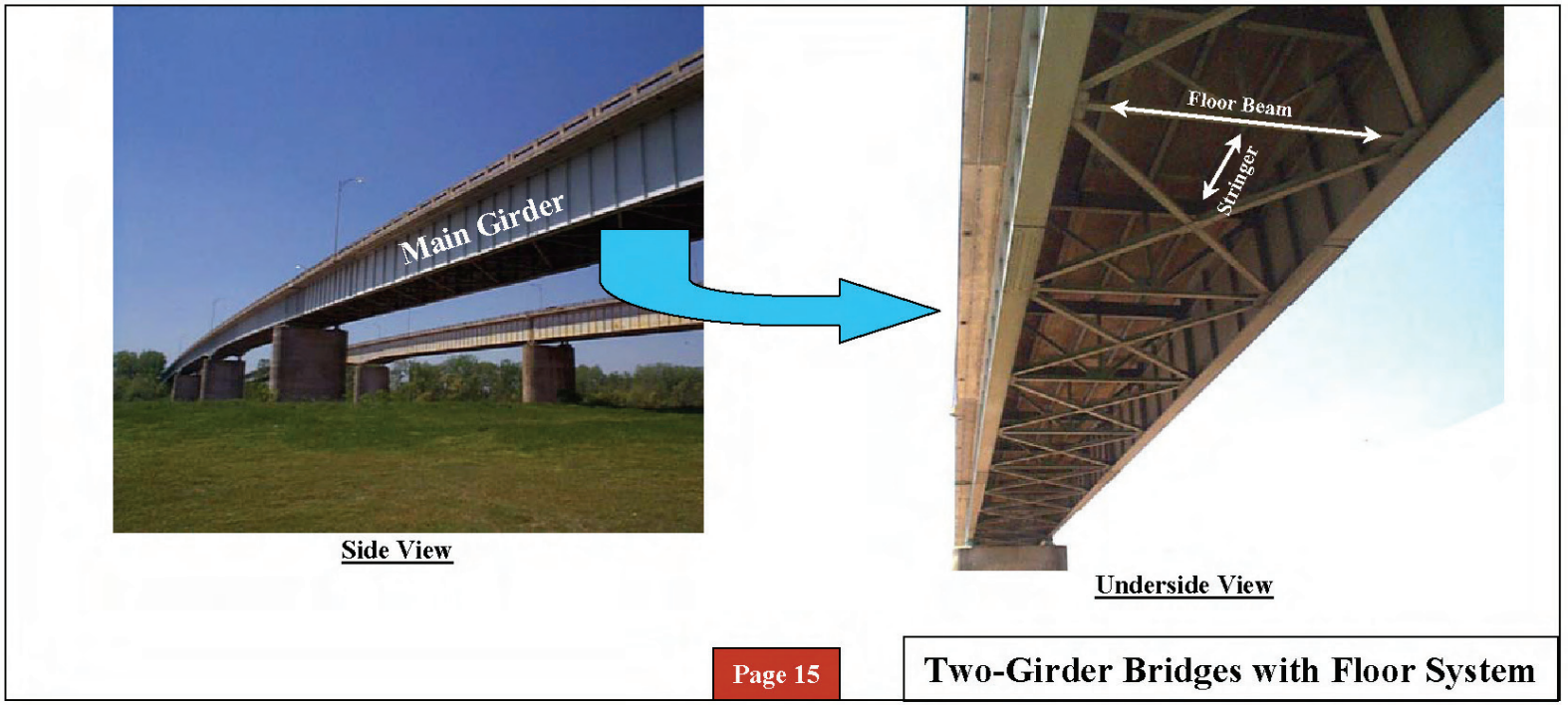


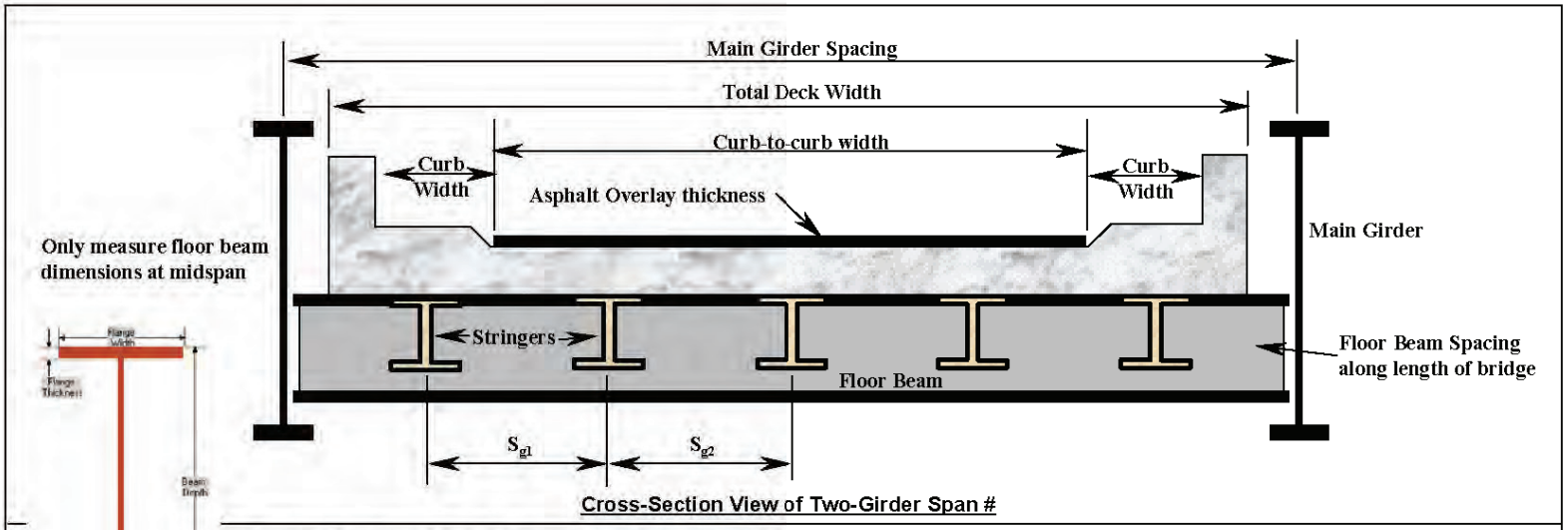
Underside View

Page 13 **Reinforced Concrete or Prestressed Bridges**



- **Provide cross-sectional details of each span as shown above.**
- **Take all measurements at midspan only.**

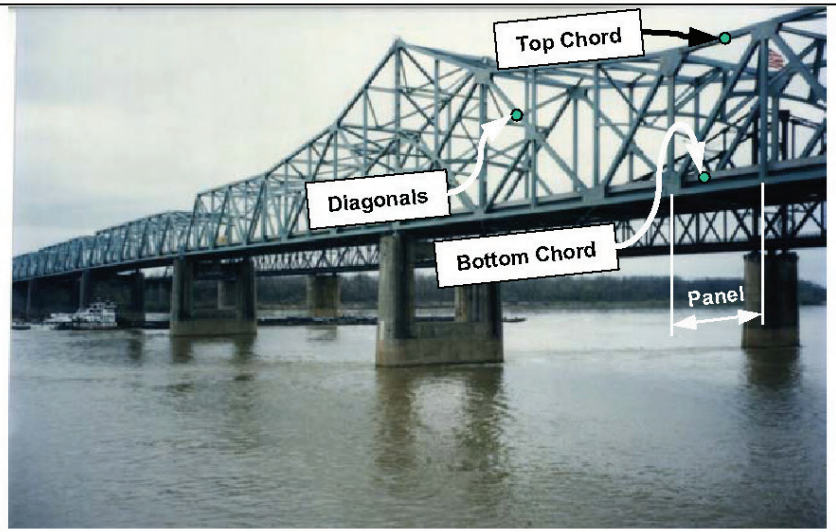

Main Girder
Side View
Floor Beam
Stringer
Underside View
Page 15
Two-Girder Bridges with Floor System



Provide complete dimensions and spacings of girders, stringers, floorbeams, and deck as shown above.

Page 16

Two-Girder Bridges with Floor System

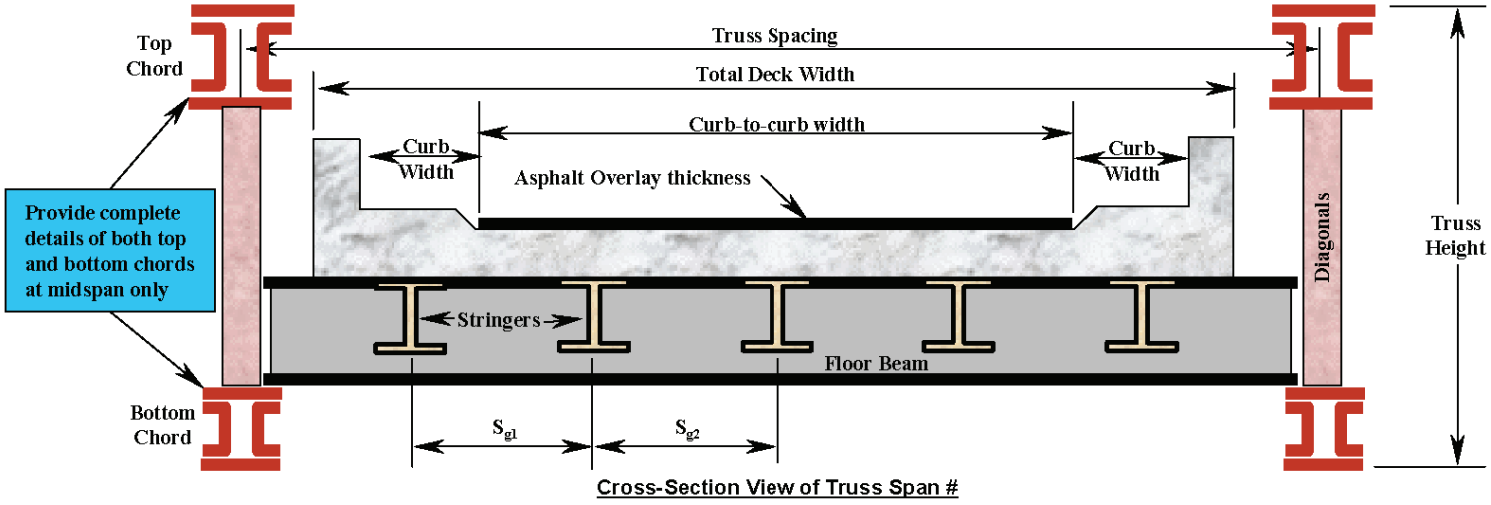


Side View

Underside View

Page 17

Truss Bridges

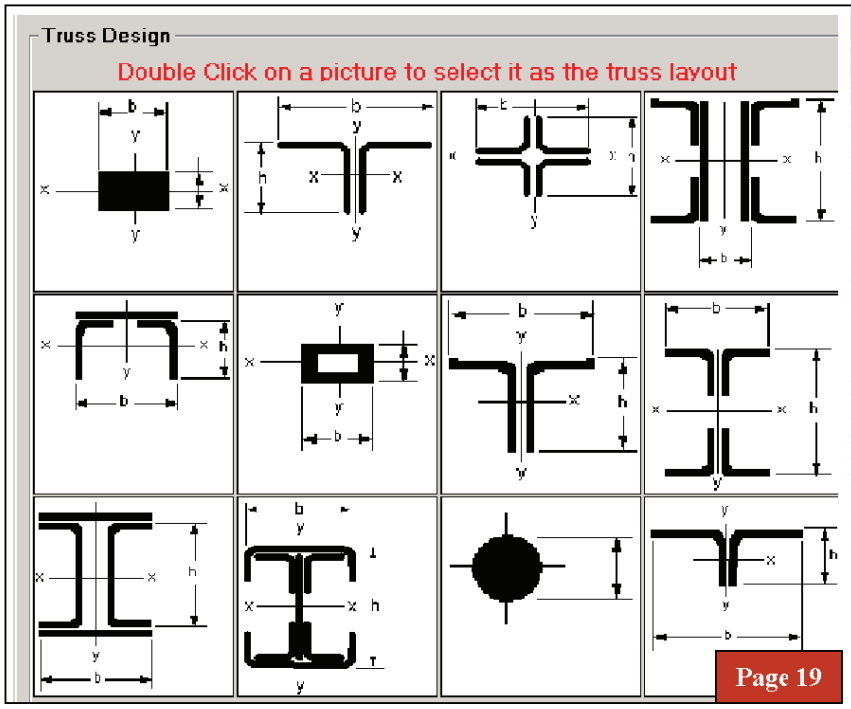


Cross-Section View of Truss Span #

In addition to truss chord dimensions at midspan, provide complete dimensions of stringers, floorbeams, and deck as shown above.

Page 18

Truss Bridges

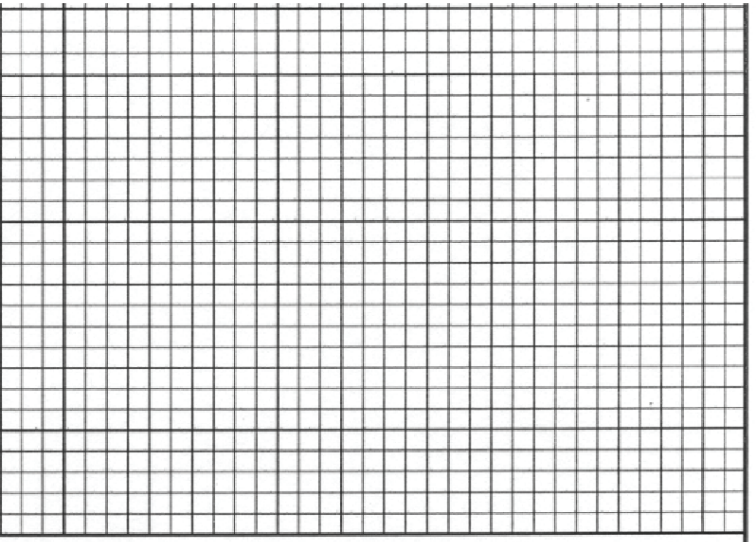


c. CROSS SECTION OF CRITICAL MEMBER

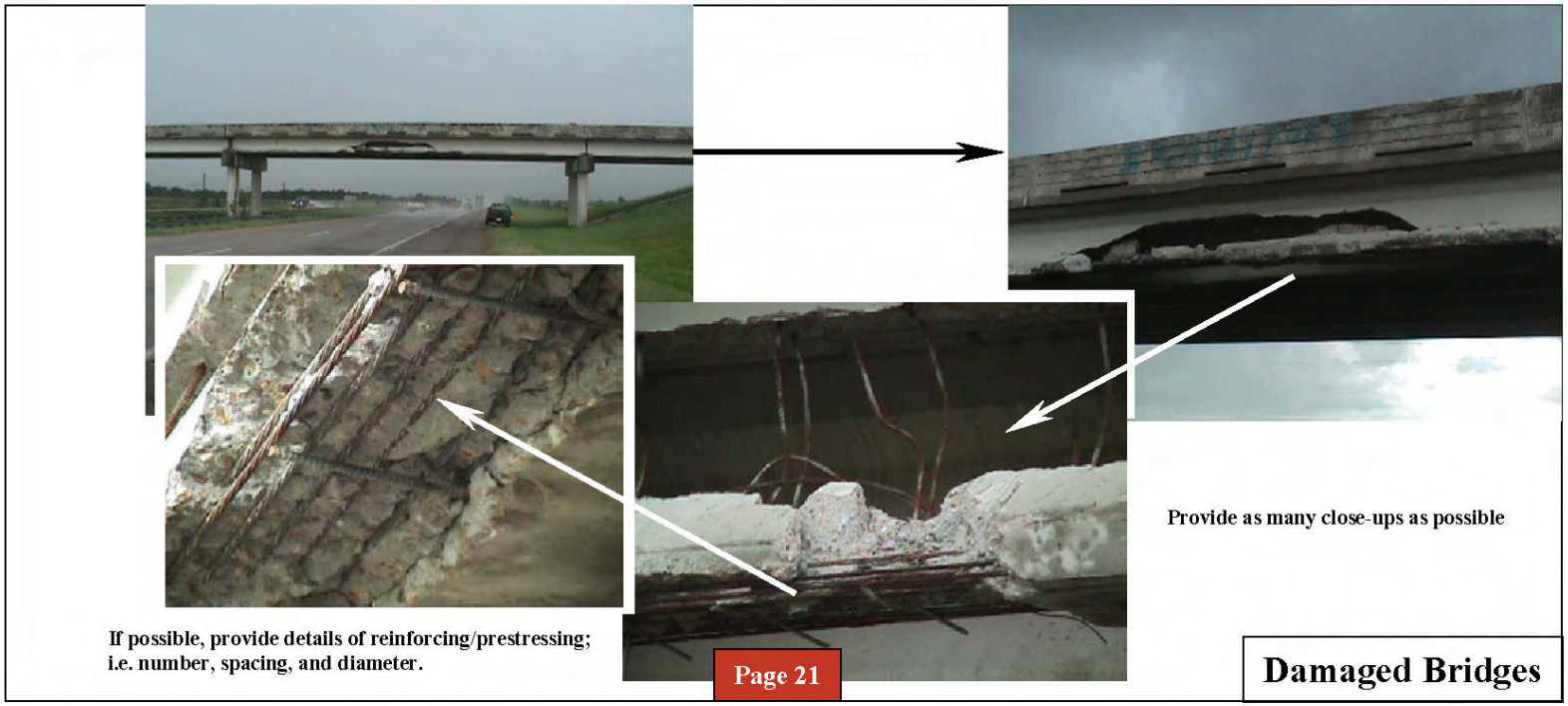
SCALE
1 SQUARE =

24. Computation of Bridge Class

c. CROSS SECTION OF CRITICAL MEMBER	SCALE 1 SQUARE =



24. Computation of Bridge Class


Provide as many close-ups as possible
If possible, provide details of reinforcing/prestressing; i.e. number, spacing, and diameter.
Page 21
Damaged Bridges

GOOD CONDITION - some minor problems.

FAIR CONDITION - all primary structural elements are sound but may have minor section loss, minor cracking, minor spalling or minor scour.

POOR CONDITION - advanced section loss (section loss that is measurable), advanced deterioration, advanced spalling or advanced scour.

1. **Define all bridge structural details using the appropriate bridge reconnaissance sheets as shown on previous pages.**

2. **Define damage to bridge as follows:**

    a. **Cause of Damage (i.e. Air-to-surface weapon, hand-emplaced explosives, vehicle impact, etc.)**
    b. **Span number and location along length of span (ft or meters) of damage**
    c. **Member(s) that are damaged (i.e. girder # 4, x-feet from North edge of bridge)**
    d. **Type of damage (i.e. bent or severed members, cratered concrete, etc.)**
    e. **Dimensions of damage (see examples next page):**

Damaged Bridges

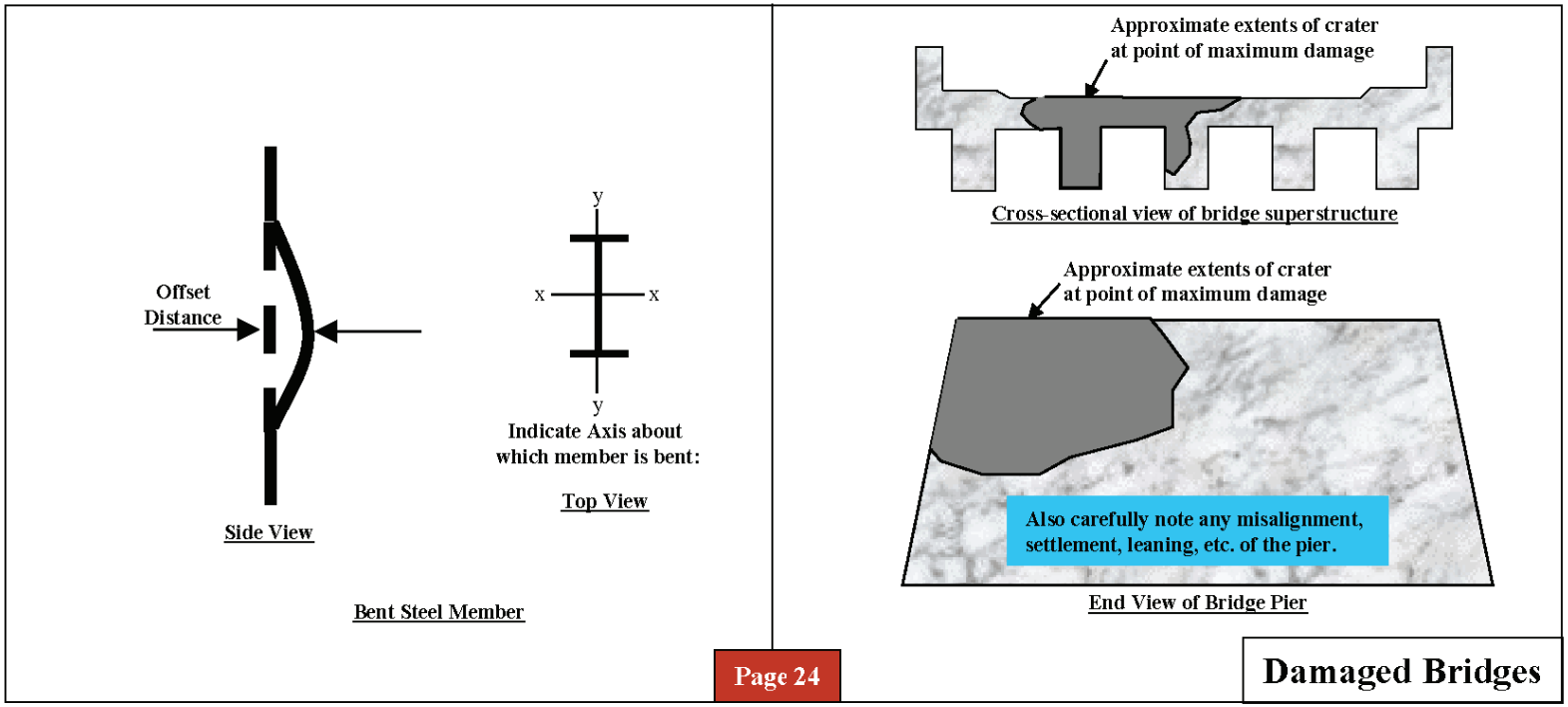
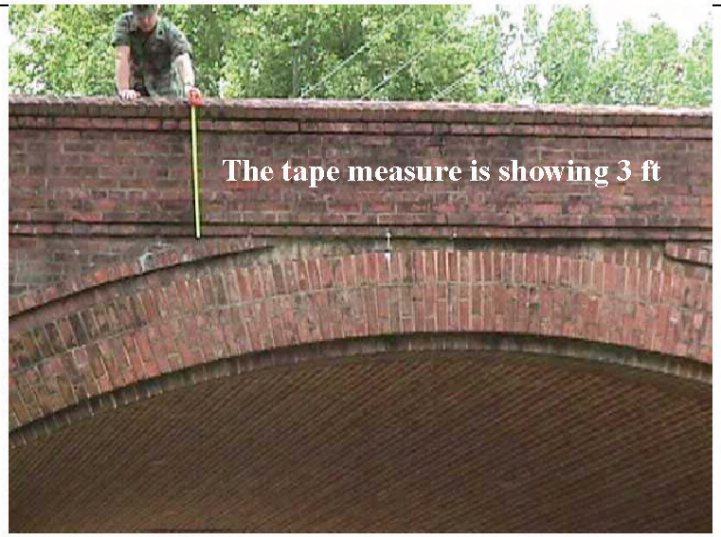

Offset
Distance
Side View
y
x
x
y
Indicate Axis about
which member is bent:
Top View
Bent Steel Member
Approximate extents of crater
at point of maximum damage
Cross-sectional view of bridge superstructure
Approximate extents of crater
at point of maximum damage
Also carefully note any misalignment,
settlement, leaning, etc. of the pier.
End View of Bridge Pier
Page 24
Damaged Bridges

Photo Reconnaissance Tips

1. **Along Route**
2. **Side View**
3. **Underside of Spans "Condition"**



Whenever possible, provide a reference scale for measurement in all photos.

Provide as many "close-ups" of main structural members as possible.

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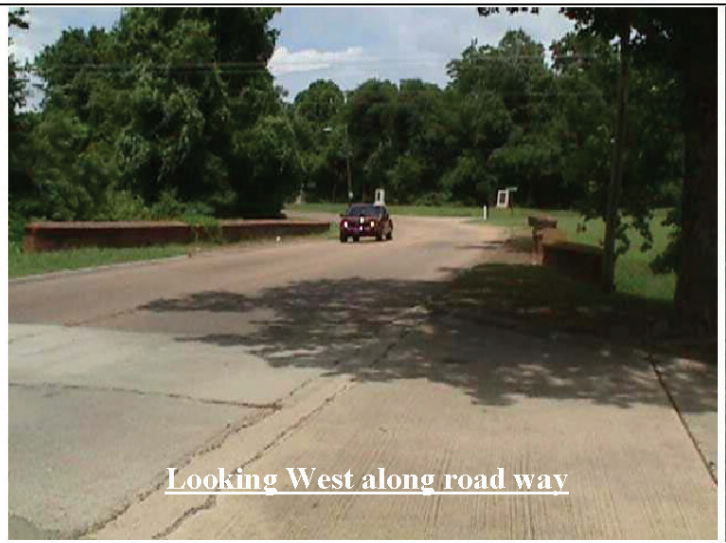
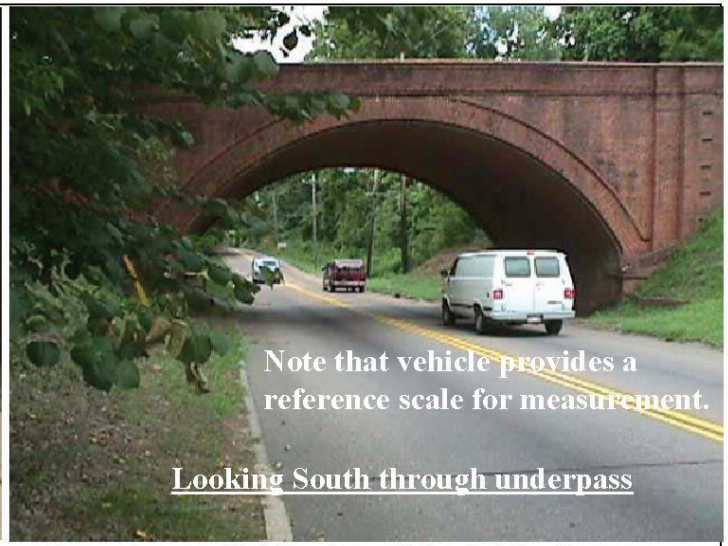
Photo Reconnaissance



Top view along length of bridge is helpful, but least useful of all photos



A good overall side view of the bridge is very helpful; showing all spans.

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Photo Reconnaissance

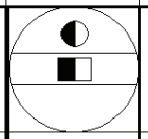
Get as close to the bridge as possible.
This is too far away.

Be careful of shadows. They make the photo useless.

Page 28

Photo Reconnaissance

BRIDGE RECONNAISSANCE REPORT For use of this form, see FM 5-36; the proponent agency is TRADOC	DATE	SIGNATURE
TO *(Headquarters Ordering Reconnaissance)*	**FROM** *(Name, Grade and Unit of Officer or NCO Making Reconnaissance)*	
MAPS *(Country, Scale and Sheet Number or Name)*	DATE/TIME GROUP *(Of Signature)*	

ESSENTIAL BRIDGE INFORMATION								ADDITIONAL BRIDGE INFORMATION *(Add Columns as Needed)* *(Military Load Class, Overall Length, Roadway Width, Vertical Clearance, Bridge By-pass)*					
		CLEARANCE		SPANS									
SERIAL NO. 1	LOCATION 2	HORIZONTAL 3	UNDER BRIDGE 4	NO. 5	TYPE OF CONSTRUCTION 6	TYPE CONSTRUCTION MATERIAL 7	LENGTH AND CONDITION 8	MILITARY LOAD CLASS	OVERALL LENGTH (meters)	VERTICAL CLEARANCE (meters)	ROADWAY WIDTH (meters)	BYPASS POSSIBILITIES	REMARKS
													

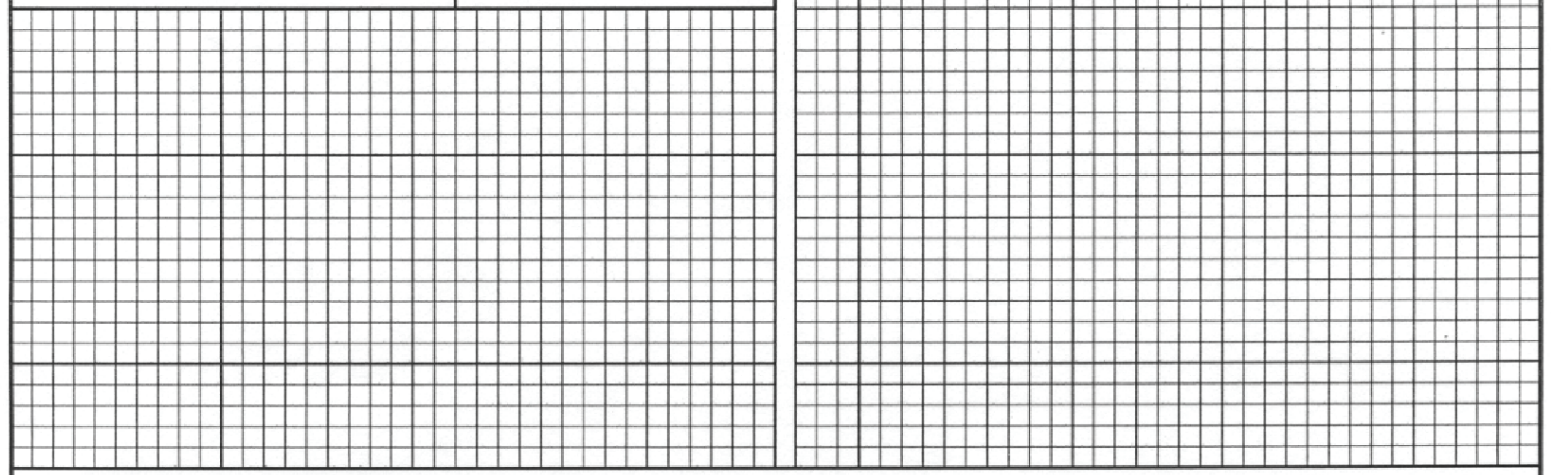
23. Sketches

a. SIDE ELEVATION

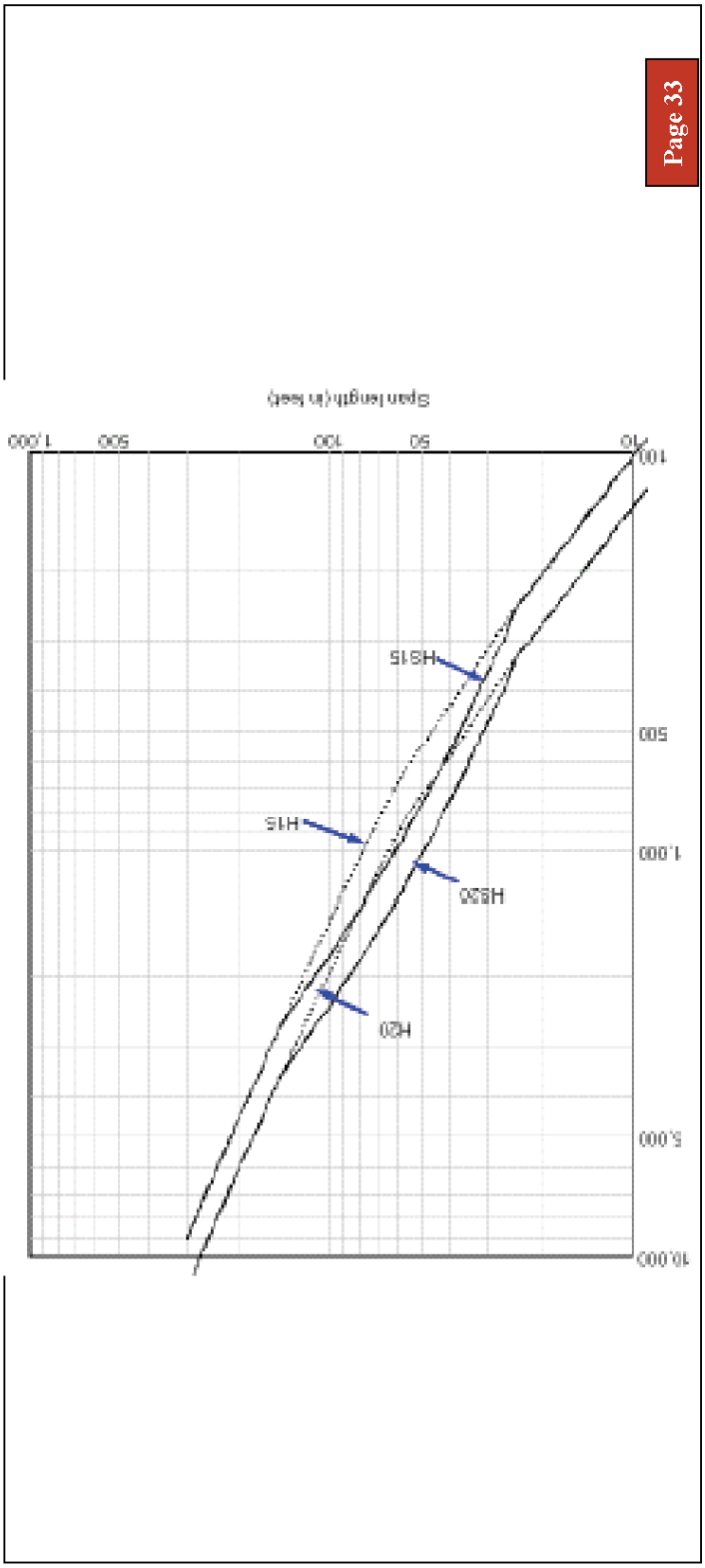
SCALE
1 SQUARE =

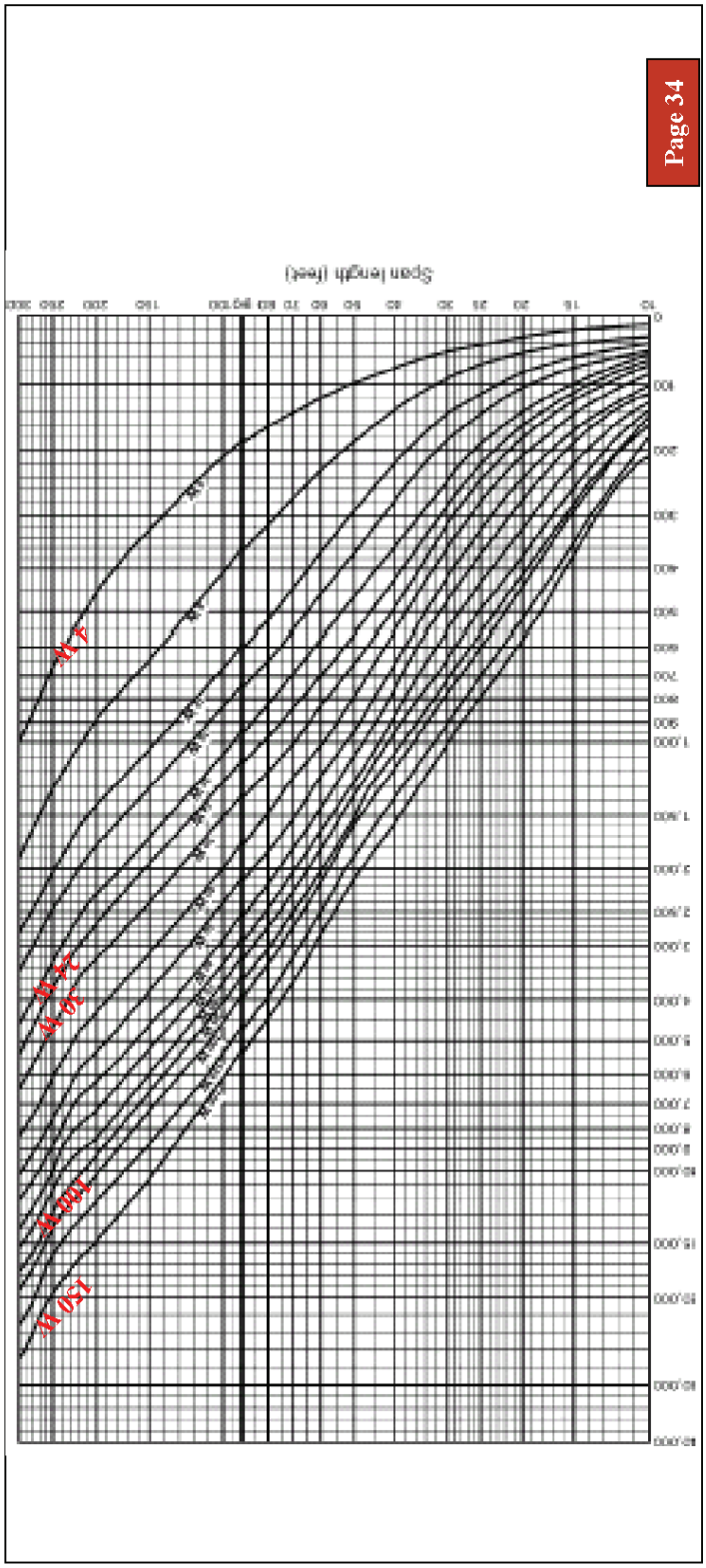
b. CROSS SECTION OF CRITICAL SPAN	SCALE 1 SQUARE =	d. SITE PLAN	SCALE 1 SQUARE =

c. CROSS SECTION OF CRITICAL MEMBER | SCALE 1 SQUARE =



24. Computation of Bridge Class


Span length (in feet)
70
50
100
500
1,000
100
500
1,000
5,000
10,000
HS15
H15
HS20
H20


Page 34
Span length (feet)

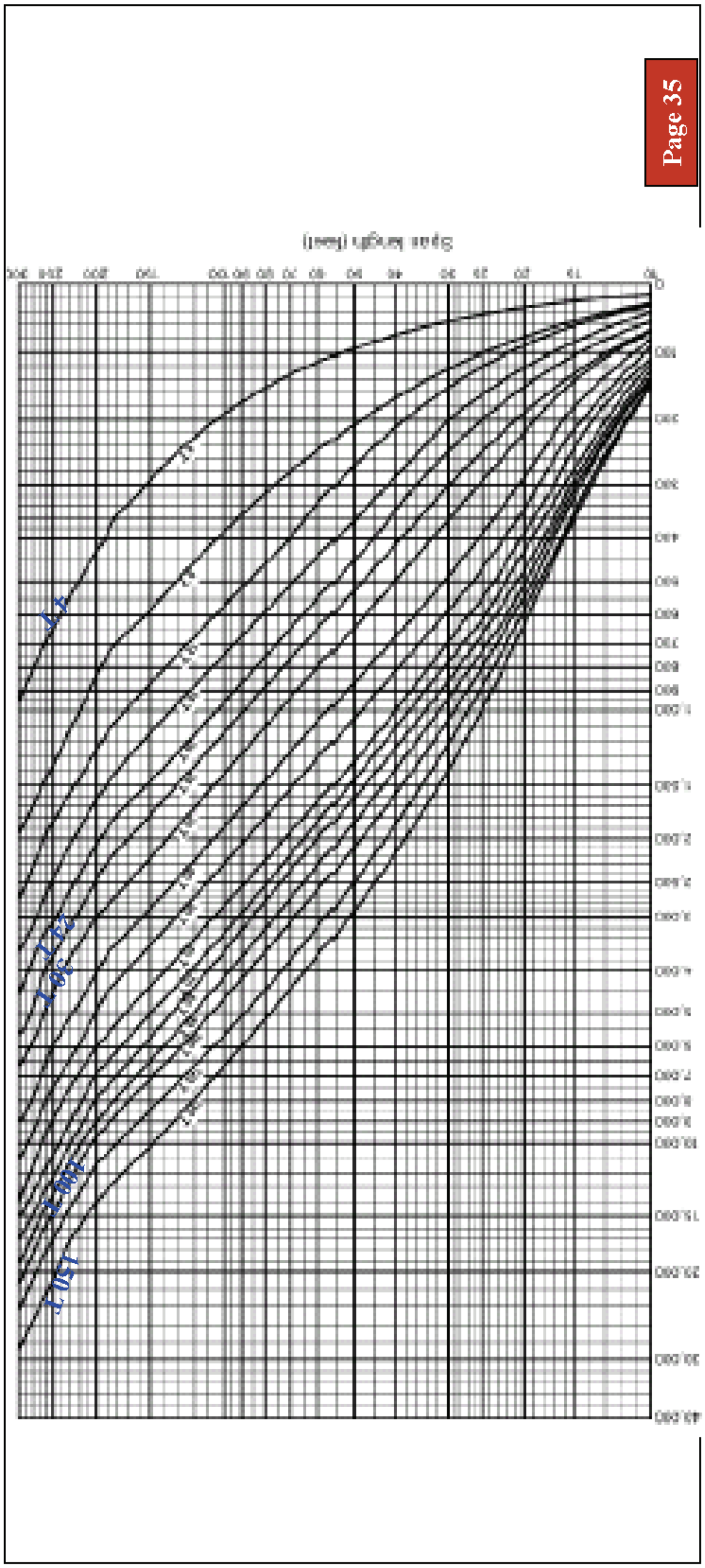

Page 35
Span length (feet)
150 T
100 T
30 T
24 T
4 T

Table 5-1. Special-Crossing Considerations

Considerations	Type of Crossing		
	Normal	Caution	Risk
Classification	As posted	Standard bridges: as published	Standard bridges: as published
		Nonstandard bridges: 125 percent of normal one-way classification	Nonstandard bridges: no crossing
Spacing	100 feet	150 feet	One vehicle on bridge at a time
Speed	25 mph	8 mph	3 mph
Location	In lane	Bridge centerline	Bridge centerline
Other	None	No stopping, braking, or accelerating	No stopping, braking, or accelerating; inspect the bridge after each crossing

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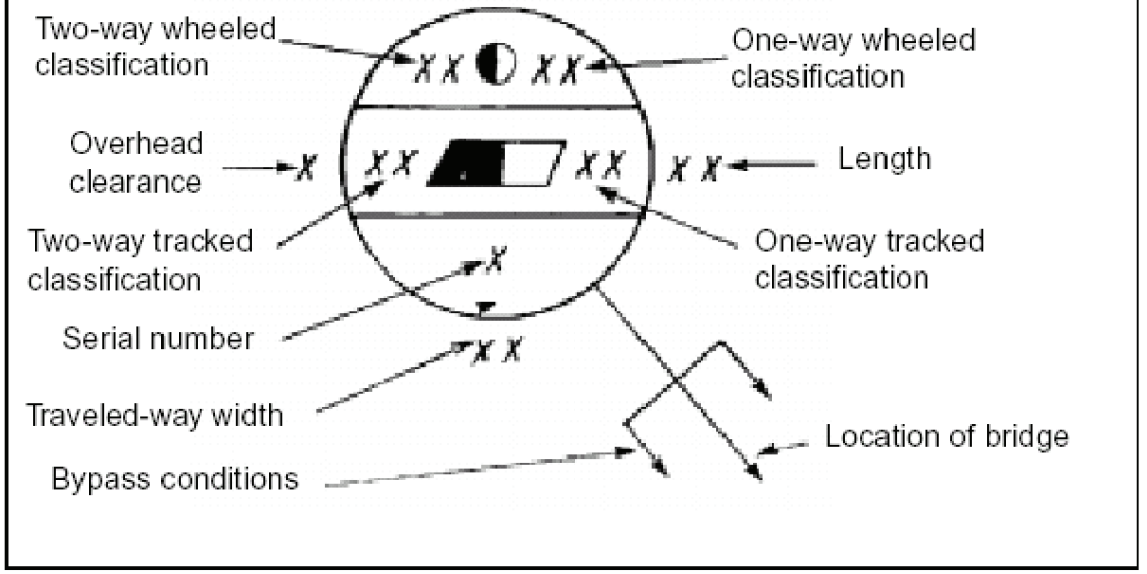

Figure 5-39. Full NATO bridge symbol

Page 37

Bridge Number_____
Bridge Name_____
Crossing_____
Location_____

Grid Coordinates_____

Date_____
From_____

REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

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December 2005	Final report	

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5b. GRANT NUMBER

5c. PROGRAM ELEMENT NUMBER

6. AUTHOR(S)

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13. SUPPLEMENTARY NOTES

14. ABSTRACT

The TeleEngineering Operations Center at the U.S. Army Engineer Research and Development Center has developed an initial capability to automate route reconnaissance. The Automated Route Reconnaissance Kit (ARRK) was developed to allow route information such as radius of curvature and slope to be determined as a vehicle is driving along the route. Other capabilities such as identifying obstacles and marking the location of bridges, ford sites, ferry sites, and tunnels are included in the ARRK. The ARRK software uses the collected data to produce a standardized route reconnaissance form that can be used for planning or executing missions.

The purpose of this report is to describe the components of the ARRK and to provide step-by-step procedures required to set up and operate the system and to process the collected data. Chapter 2 describes the components of the system. Chapter 3 provides details on installation of the equipment in a ground vehicle and the interconnections among the individual components. The setup and operation of the data collection and processing software is presented in Chapter 4. Chapters 5 and 6 explain how to collect and view the

(Continued)

15. SUBJECT TERMS

Analysis, Bridge, Ferry, Ford, Reconnaissance, Road, Route, TeleEngineering, Tunnel

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT	b. ABSTRACT	c. THIS PAGE			19b. TELEPHONE NUMBER *(include area code)*
UNCLASSIFIED	UNCLASSIFIED	UNCLASSIFIED		112	

14. ABSTRACT (Concluded)

reconnaissance data. Adding the recon data to a route database is discussed in Chapters 7 and 8. Procedures to add additional data to the route database and create a final product are described in Chapters 9 and 10; methods of receiving technical support are provided in Chapter 11. Appendix A provides quick-start instructions for the system; Appendix B provides the bridge reconnaissance requirements.